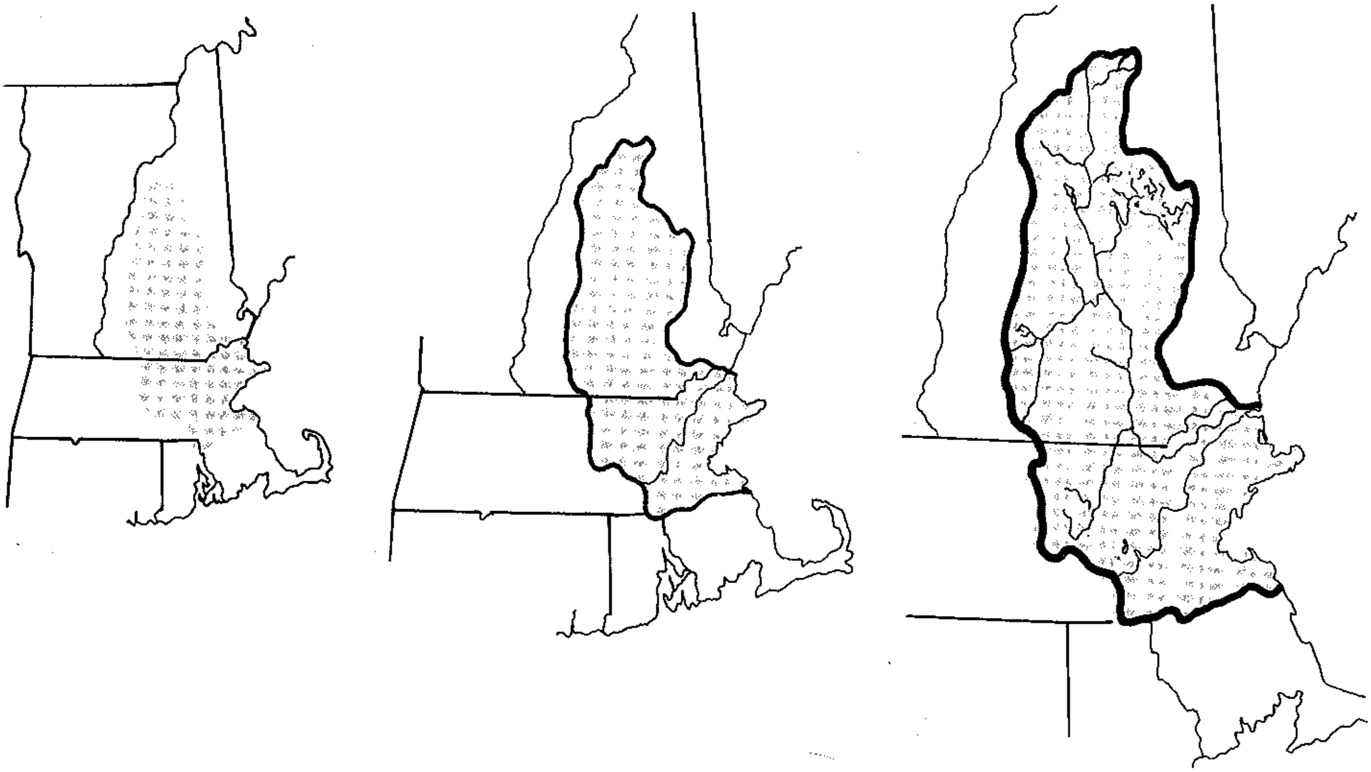
NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

WASTEWATER MANAGEMENT

MERRIMACK RIVER BASIN-BOSTON METROPOLITAN AREA



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DECEMBER 1975

PREFACE

In March and June 1972, the Committees on Public Works of the U.S. Senate and House of Representatives passed resolutions which authorized the Corps of Engineers to conduct wastewater management studies in the Merrimack River Basin and the Boston Metropolitan area as part of the overall Northeastern United States Water Supply Study.

The purpose of this report is to summarize the wastewater management studies accomplished by the U.S. Army Corps of Engineers in the Merrimack River Basin and the Boston Metropolitan area in response to the Congressional Resolutions. It includes a synopsis of the "Merrimack River Basin Plan" prepared by the New Hampshire Water Supply and Pollution Control Commission which the Congressional Resolutions directed to be utilized as the sole basis of recommendations for the New Hampshire portion of the basin. In addition, this report summarizes the wastewater management plan being accomplished by the Nashua River Program for the Nashua River Basin, a sub-basin to the Merrimack.

The Corps of Engineers' effort in the Merrimack Basin consisted of the preparation of a Feasibility Study for the entire basin in Massachusetts and New Hampshire, and a Survey Scope Study for the 24 cities and towns along the mainstem of the Merrimack River within Massachusetts.

This Report primarily presents the results of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study (BH-EMMA) which was conducted jointly by the Metropolitan District Commission and the Corps of Engineers, and other state, regional and Federal agencies. The detailed report for the BH-EMMA study comprises twenty-five (25) supporting technical volumes titled: "Wastewater Engineering and Management Plan for Boston Harbor-Eastern Massachusetts Metropolitan Area, EMMA Study" dated October 1975.

The latter portion of this Report contains an overall summary and the Reporting Officer's recommendations.

WASTEWATER MANAGEMENT
NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY
(NEWS)
MERRIMACK RIVER BASIN - BOSTON METROPOLITAN AREA

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I. AUTHORITY

The Northeastern United States Water Supply (NEWS) Study was authorized under Title I of the 1965 Flood Control Act (PL 89-298), in which the Congress recognized that assuring adequate supplies of water for metropolitan centers has become a problem of such magnitude that the welfare and prosperity of the Nation require Federal Government assistance in the solution of water supply problems. The Act directs the Secretary of the Army, acting through the Chief of Engineers, to cooperate with Federal, State and local agencies in preparing plans in accordance with the 1965 Water Resources Planning Act (PL 89-80) to meet the long-range water needs of the northeastern United States.

The Chief of Engineers assigned responsibility for the NEWS study to the Division Engineer, North Atlantic Division, New York, New York.

Early studies under the NEWS authority identified the Merrimack River as a potential future source of water supply for the Metropolitan Boston region. However, the studies recognized that the Merrimack River was highly polluted and should be substantially cleaner before it could become a reliable water supply source.

In recognition of this fact, the Chief of Engineers sought and received authority in April of 1971 from the Office of Management and Budget and the Appropriations Committees of both Houses of Congress to reallocate NEWS funds to conduct a pilot Wastewater Management Study in the Merrimack River Basin in New Hampshire and Massachusetts.

In March and June of 1972, the Committees on Public Works of the U.S. Senate and House of Representatives passed the following resolution:

"Resolved by the Committee on Public Works of the House of Representatives, United States, That the Secretary of the Army, acting through the Chief of Engineers, is hereby requested, in connection with the preparation of plans to meet the long-range water needs of the northeastern United States as authorized by section 101 of Public Law 89-298, to cooperate with the Commonwealth of Massachusetts in conducting a joint study to recommend improvements in wastewater management and alternatives thereto for that portion of the Merrimack Basin and tributaries thereto within the Commonwealth of Massachusetts and the Boston metropolitan area. The scope of such study shall be established with the consultation of the Commonwealth of Massachusetts and the Environmental Protection Agency and shall include measures for wastewater management including cleanup and restoration in the interest of water supply, environmental quality, recreation, and fish and wildlife and shall incorporate the overall water resources and wastewater management implementation program previously determined by the Commonwealth of Massachusetts and approved by the Environmental Protection Agency. In order to avoid duplication of effort and expense, as well as to provide the orderly implementation of the studies and investigations authorized by this resolution, the Corps of Engineers is hereby directed to use the findings and recommendations of the New Hampshire Water Supply and Pollution Control Commission as published in the Commission's report titled "Merrimack River Basin Plan," February 1972, and any amendments thereto, as the sole basis for the Corps' recommendations relating to the New Hampshire portion of the Merrimack River Basin."

II. PURPOSE AND OBJECTIVE

The purpose of this report is to summarize the wastewater management studies accomplished by the U.S. Army Corps of Engineers and others in the Merrimack River Basin and to present the results of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study. Since the wastewater management studies in the Merrimack River Basin have been previously reported, they are not presented in any detail in this report.

This report is presented in fulfillment of the Congressional Resolutions cited in Chapter I and as an Interim Report to the overall Northeastern United States Water Supply Study under PL 89-298.

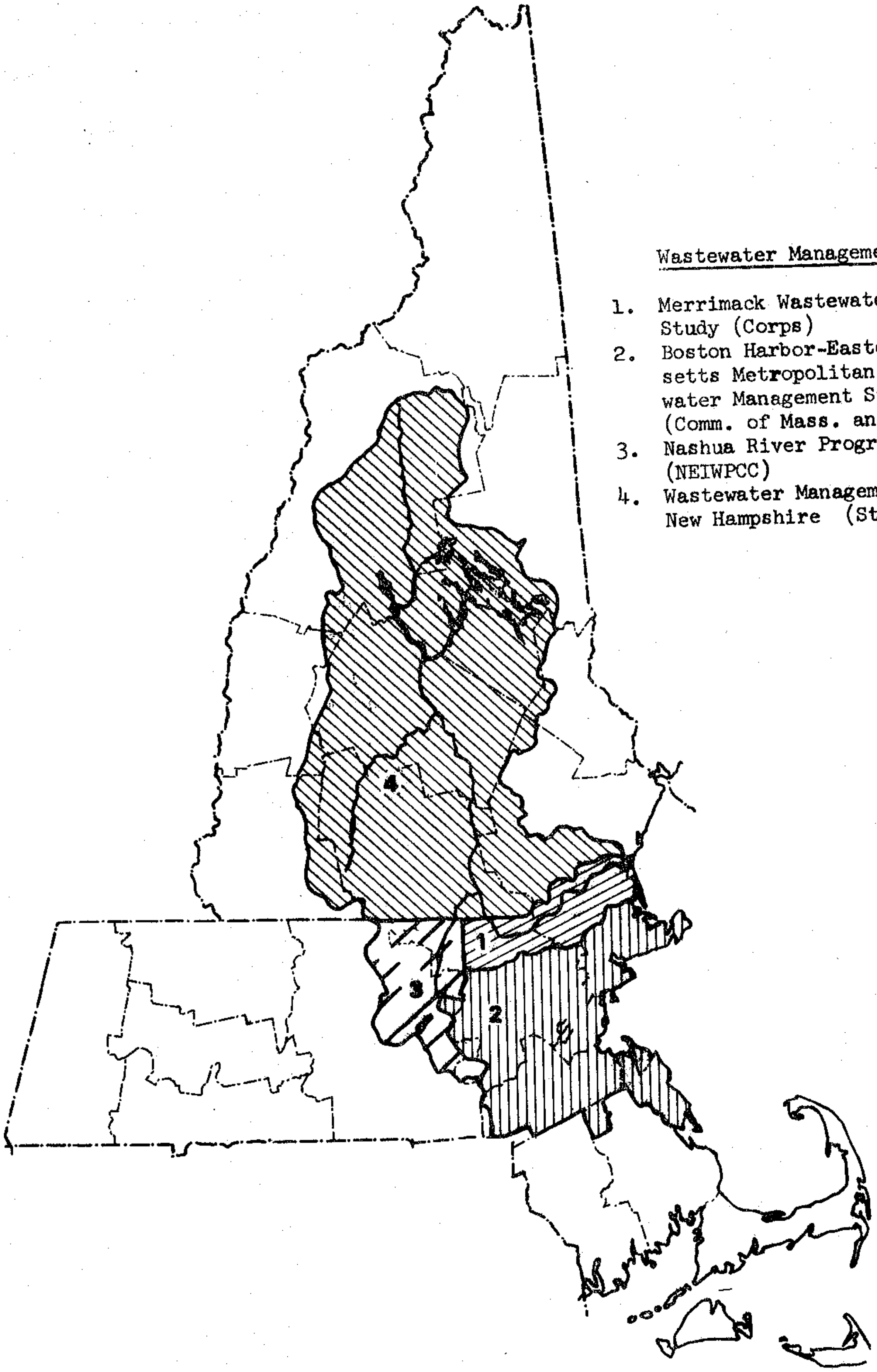
The objective of the report is to bring together all wastewater management efforts in the Merrimack River Basin and the Boston Metropolitan area.

III. STUDY AREA AND RESPONSIBLE STUDY AGENCY

A. The Merrimack River Basin

The Merrimack River Basin lies in central New England and extends from the White Mountains region of New Hampshire southward into the east central part of Massachusetts. It is bounded by the Connecticut River Basin on the west and northwest, the Saco and Piscataqua River Basins on the northeast and east, New Hampshire and Massachusetts Coastal Streams on the east and southeast, and the Blackstone River Basin and the Narragansett Bay Drainage Basin on the south. This basin, the fourth largest of those lying wholly in New England, has a maximum length in a north-south direction of 134 miles and a width of 68 miles. It has an area of 5,010 square miles of which 3,800 square miles are in New Hampshire and 1,210 square miles are in Massachusetts.

The Merrimack and Wastewater Management Feasibility Study focused on the congested urban and industrial areas within the basin responsible for the heaviest pollution loads and most in need of future water supplies. These sub-regions included the developing area along the Winnipesaukee River and the Cities of Concord, Manchester and Nashua in New Hampshire, and the Cities of Fitchburg, Leominster, Lowell, Lawrence and Haverhill in Massachusetts. Areas outside the boundaries of the basin were included only to the extent that their water supply needs or capabilities for wastewater renovation affected planning in the Merrimack River Basin.



Wastewater Management Studies

1. Merrimack Wastewater Management Study (Corps)
2. Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study (Comm. of Mass. and Corps)
3. Nashua River Program (NEIWPCC)
4. Wastewater Management Plan for New Hampshire (State of N.H.)

FIGURE 1

The Merrimack Wastewater Management Feasibility Study was conducted by a special Task Force consisting of Corps of Engineers personnel, staff from several Federal agencies, including the U.S. Geological Survey, Environmental Protection Agency, and the Soil Conservation Service, and consultants all under the direction of the North Atlantic Division, Corps of Engineers. The study was completed in September 1971.

Following the Merrimack Feasibility Study, the New Hampshire Water Supply and Pollution Control Commission was relied upon as having responsibility for all wastewater management study efforts within the Merrimack River Basin in New Hampshire.

The Nashua River Basin was selected by the Environmental Protection Agency for a demonstration program in water quality management. The objective of the demonstration program was to bring together all State, Federal and local agencies having responsibility for the Nashua River Basin, to exert their effort to expedite the cleanup of the Nashua River. After a series of negotiations dating back to 1971, the New England Interstate Water Pollution Control Commission was awarded a contract on 1 February 1973 by the New England Regional Commission to administer the Nashua River Program. To avoid duplication of effort, the Corps of Engineers agreed that the Nashua River Program should conduct the wastewater management studies in the entire Nashua River Basin. The Corps of Engineers has served with other State and Federal agencies on the Program Advisory Committee for the Nashua River Program.

B. The Boston Metropolitan Area

In the same time period that the Corps of Engineers received and was preparing to carry out the Congressional Resolutions of March and June 1972, the Metropolitan District Commission was initiating a Wastewater Management Study in the Boston Metropolitan Area. In a series of meetings, the Corps of Engineers agreed with the Metropolitan District Commission to carry out a joint study to be called "Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study. The Sudbury-Assabet-Concord River Basin (SUASCO), tributary of the Merrimack River, was included as part of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study rather than as part of the Merrimack Wastewater Management Study because a number of the SUASCO communities were already served by the Metropolitan Sewerage District.

The remaining communities lying along the mainstem of the Merrimack River in Massachusetts were the subject of the Merrimack Wastewater Management Study, which was conducted by the Corps of Engineers and completed in November 1974.

Figure 1 shows the geographical relationship of the studies.

IV. SUPPORTING REPORTS

The following separate reports formed a basis for this Report:

- Merrimack Wastewater Management Feasibility Study, "Designs for a Clean River," dated September 1971, prepared by the Corps of Engineers.

- Merrimack River Plan, dated February 1972, and "Merrimack River Basin Water Quality Management Plan," dated November 1973, prepared by the New Hampshire Water Supply and Pollution Control Commission.

- Merrimack Wastewater Management Study, "Key to a Clean River," dated November 1974 prepared by the Commonwealth of Massachusetts and the Corps of Engineers.

- "Wastewater Engineering and Management Plan for Boston Harbor-Eastern Massachusetts Metropolitan Area, EMMA Study," dated October 1975, prepared by the Metropolitan District Commission and the Corps of Engineers.

- "Water Quality Management Plan, Nashua River Basin," prepared by the New England Interstate Water Pollution Control Commission and the Nashua River Program, dated December 1975.

THE MERRIMACK RIVER ESTUARY

V. MERRIMACK WASTEWATER MANAGEMENT STUDY

A. Feasibility Study

In September 1971, the Corps of Engineers completed a Feasibility Study on wastewater management for the entire Merrimack River Basin. The report was titled "The Merrimack: Designs for a Clean River."

This was one of five such feasibility studies authorized; the others examined the wastewater problems of San Francisco, Chicago, Detroit and Cleveland. All five were carried out by the Corps of Engineers within a cooperative agreement between the Department of the Army and the Environmental Protection Agency. The work in the Merrimack Basin was performed by a special Task Force made up of Corps personnel, staff from several Federal agencies, including the U.S. Geological Survey, and the Soil Conservation Service, and consultants, all under the direction of the North Atlantic Division, Corps of Engineers.

The Feasibility Study was accomplished prior to the passage of PL 92-500, Federal Water Pollution Control Act Amendments of 1972. However, the study team anticipated most of the strong public feelings and opinions on water pollution and utilized the "thorough elimination of pollutants" as the principal objective of the study. In view of this, the study developed wastewater management systems and their costs using treatment processes which could achieve this objective.

The study viewed the 5,012 square mile basin in Massachusetts and New Hampshire and concentrated its efforts on the six major pollution producing regions in the basin; namely, Winnipesaukee River region, Concord, Manchester, Nashua, Fitchburg-Leominster and Lowell-Lawrence-Haverhill areas. Seven technical alternatives were developed with various degrees of regionalization and were based on water-oriented type wastewater treatment facilities, land application type treatment facilities and combinations thereof.

B. Survey Scope Study

The Feasibility Study was subsequently expanded by a Survey Scope effort which was commenced in August 1972 and completed in November 1974. The results and findings are included in a report prepared by the Corps of Engineers, dated November 1974, titled: "Merrimack Wastewater Management Study - Key to a Clean River."

While the two studies differed in their level of detail, one of the major differences between the Feasibility and the Survey Scope was the extent of the study area itself. The Feasibility Study addressed the entire Merrimack River Basin including that portion within the State of New Hampshire. The Survey Scope Study, however, as directed by Congressional resolutions was confined to the Massachusetts' portion of the Merrimack River Basin which encompassed approximately 1,210 square miles. Coordination was made with the following ongoing wastewater management studies in the Commonwealth of Massachusetts: (1) the Nashua River Program under the auspices of the New England Interstate Water Pollution Control Commission, and (2) the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study under the direction of the Metropolitan District Commission. These other studies enabled the Survey Scope Study to focus its efforts on the twenty-four (24) communities along the mainstem of the river. The Cities of Lowell, Lawrence and Haverhill are the largest metropolitan-industrial centers within the study area. Together the twenty-four cities and towns investigated, constitute the jurisdiction of the Northern Middlesex Area Commission (9 towns) and the Merrimack Valley Regional Planning Commission (15 towns).

The ongoing EPA-State Program in the study area was used as a basis for formulating the alternatives. In addition, the study addressed the 1977, 1983 and 1985 requirements, goals and objectives of PL 92-500 and separate costs estimates for attaining the various goals were prepared.

Six technical alternatives and one "preferred plan" were developed by the joint Corps-Commonwealth of Massachusetts-Regional Planning Agency study team in coordination with the Environmental Protection Agency. The plans were based on land and water-oriented type treatment facilities and combinations of each. The estimated total capital cost of the "preferred plan" was approximately $722,000,000 with an Annual Operation and Maintenance cost of about $8,840,000. Figure 2 shows the "preferred plan" and Table 1 provides an Impact Assessment Summary of the technical alternatives.

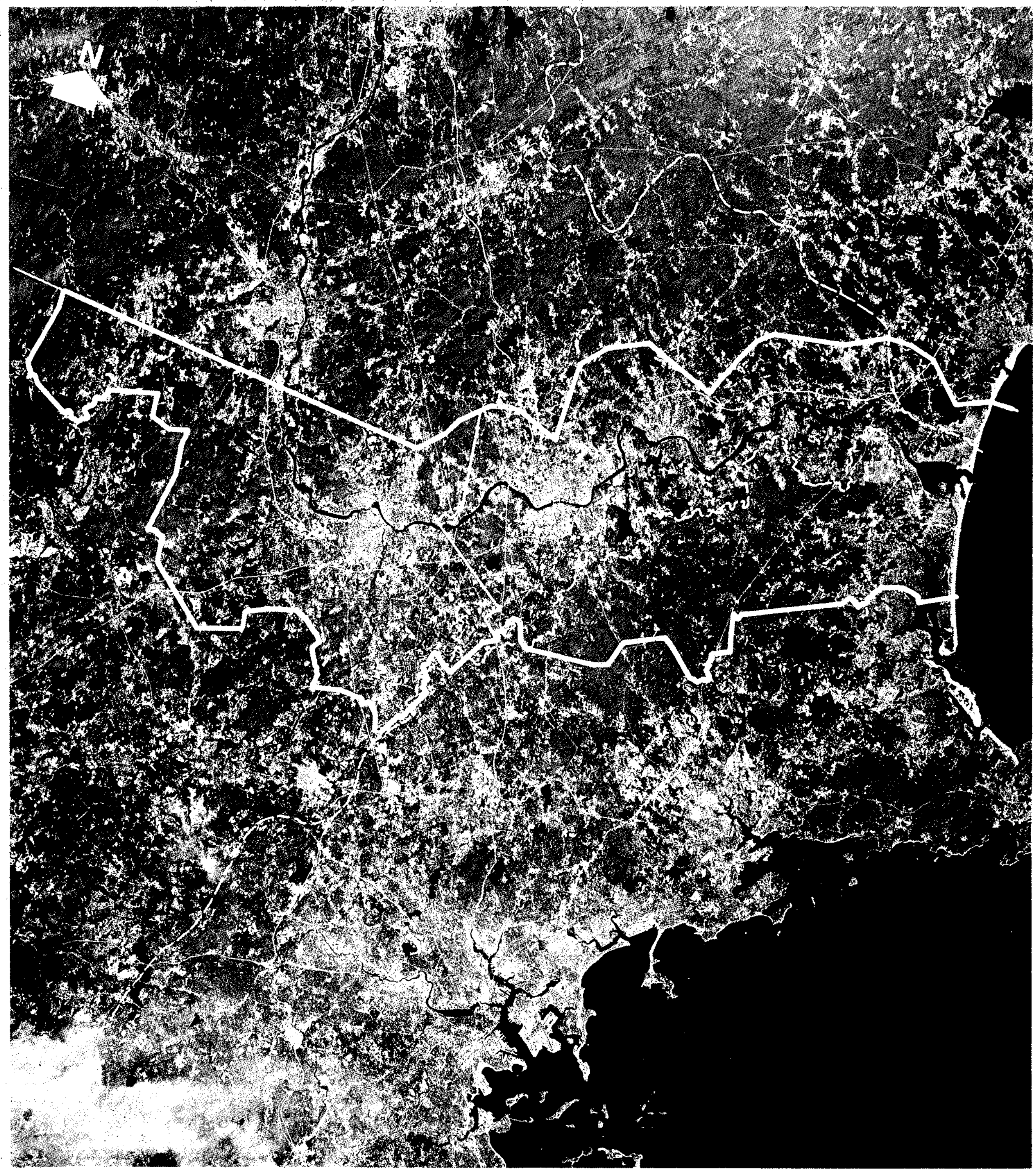
The Merrimack Wastewater Management Study was reviewed by the Board of Engineers for Rivers and Harbors on 7 October 1975. On 14 October 1975, the Board issued a Public Announcement that it concurred in general with the conclusions and recommendations contained in the report.

MERRIMACK WASTEWATER MANAGEMENT ■ IMPACT ASSESSMENT SUMMARY

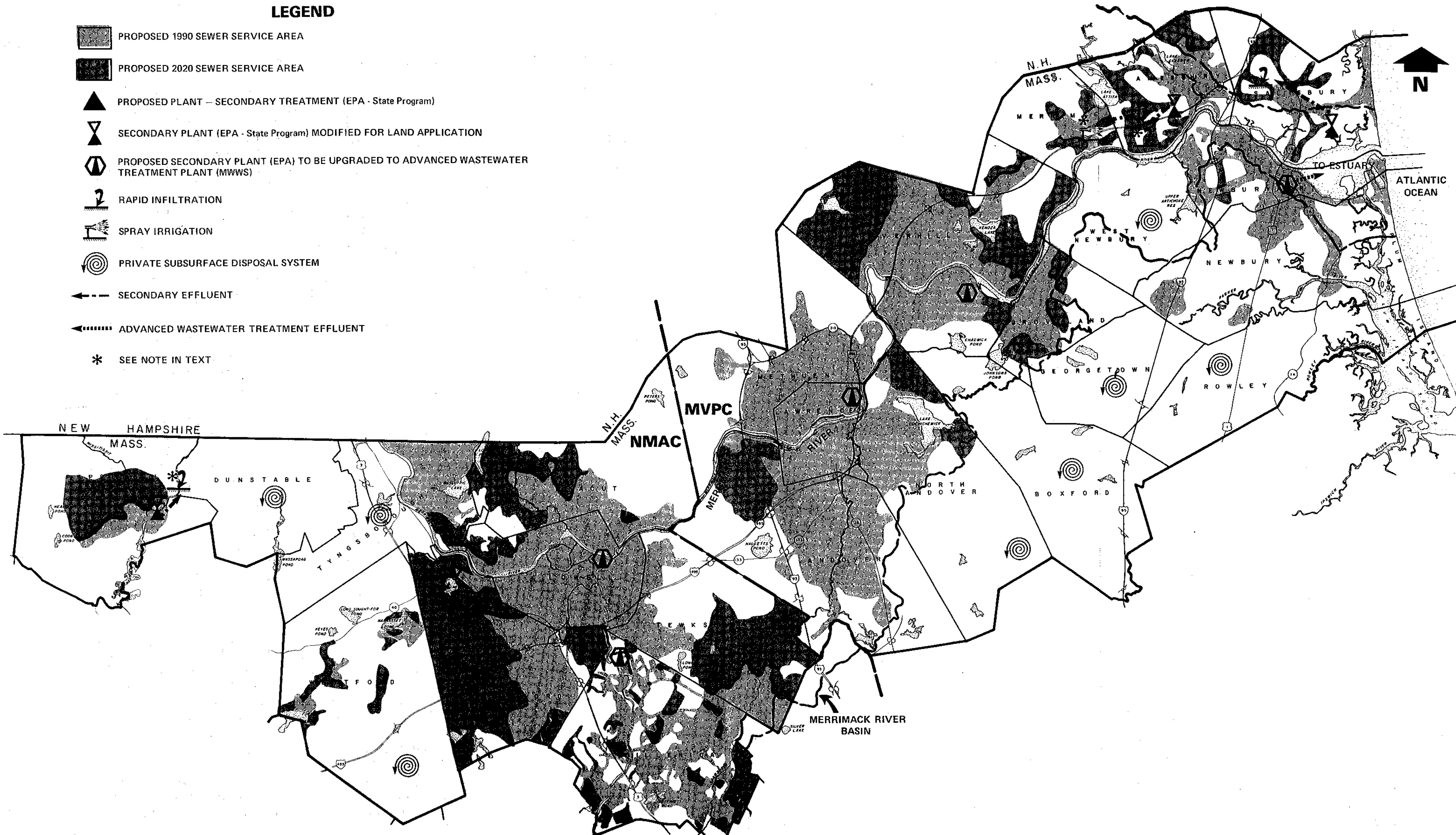
OBJECTIVES		BENEFITS AND COSTS OF ALTERNATIVES STATE-EPA IMPLEMENTATION PROGRAM	IMPACTS COMMON TO WATER-ORIENTED ALTERNATIVES	ALTERNATIVE #1 (WATER DECENTRALIZED)	ALTERNATIVE #2 (WATER PARTIALLY DECENTRALIZED)	ALTERNATIVE #3 (WATER CENTRALIZED)	ALTERNATIVE #4 (WATER REGIONAL)	IMPACTS COMMON TO LAND-ORIENTED ALTERNATIVES	ALTERNATIVE #5 (LAND DECENTRALIZED)	ALTERNATIVE #6 (MVPC ONLY) (LAND CENTRALIZED)	RECOMMENDED PLAN
ENVIRONMENTAL QUALITY	Benefits:	**Water Quality:** Improved visual quality of Merrimack River. **Aesthetic Values:** Proper treatment plant design and landscaping could accommodate need for river access points.	**Water Quality:** Nutrient concentrations will be reduced to acceptable limits. Gamefish populations will increase. **Aesthetic Values:** Transmission systems provide opportunities for recreational pursuits.	**Water Quality:** A number of small treatment plants effectively operated could best insure maximum water quality improvement.	**Water Quality:** Same as Alternative #1	**Aesthetic Value:** Extensive transmission systems provide multiple use opportunities consistent with regional land use and recreation plans.	**Water Quality:** Large volumes of water centrally located could take maximum advantage of potential reuse opportunities, i.e. water supply.	**Water Quality:** Nutrients currently being discharged to local streams would be utilized by agricultural crops. Groundwater recharge stabilizes local aquifers. Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.	**Terrestrial Environment:** 1895 acres of spray irrigation sites could enhance wildlife productivity. Effluent nutrients would be available for crop uptake.	**Terrestrial Environment:** 1480 acres of spray irrigation sites could enhance wildlife productivity. **Water Quality:** Flow augmentation during summer months would enhance aquatic life.	**Water Quality:** Nutrient concentrations in Merrimack River will be reduced to acceptable levels. Gamefish populations will increase. A number of small treatment plants effectively operated could best insure maximum water quality improvement. Where land treatment systems are proposed, nutrients currently being discharged to local streams would be utilized for agricultural production and groundwater recharge would assist the stabilization of local aquifers. **Aesthetic Values:** Transmission systems provide opportunities for recreational pursuits if proper consideration is given to planning and design.
	Costs:	**Water Quality:** Non-point sources, combined sewer overflows and efficiency of secondary treatment plants may prohibit achievement of designated water quality standards. Chlorination may cause adverse impact on aquatic organisms.	**Water Quality:** The effectiveness and reliability of advanced waste treatment systems is questionable. Considering possibilities of treatment plant failure, direct discharges to receiving streams would have an adverse impact on aquatic organisms. Chlorination may cause adverse impact on aquatic life.	**Water Quality:** Reduced operational efficiency probable with a number of small treatment plants will not produce maximum water quality improvement.	**Water Quality:** Regional treatment systems will reduce flow in small feeder streams. See Alternative #1.	**Water Quality:** Regional configurations reduce flow of smaller feeder streams. The malfunction of large treatment plants would have a major adverse impact on aquatic organisms. **Aesthetic:** large treatment plants will disrupt natural riverscape views.	**Water Quality:** Reduction of river flow would have adverse impact on aquatic organisms. The malfunction of large treatment plants would have a major adverse impact on aquatic organisms.	**Aesthetic Values:** Rapid infiltration systems degrade natural landscape. **Terrestrial Environment:** Construction of rapid infiltration systems will reduce wildlife habitat.	**Terrestrial Environment:** 995 acres of rapid infiltration systems degrade natural landscape. Spray irrigation systems can only be effectively utilized approximately 26-weeks.	**Terrestrial Environment:** 1315 acres of rapid infiltration systems will degrade natural landscape. See Alternative #5.	**Water Quality:** Potential chlorine residual toxicities to aquatic organisms. Reduced operational efficiency probable with a number of small treatment plants would not maximize water quality improvements. Treatment plant failure would have an adverse impact on aquatic life. **Aesthetic Values:** 650 acres of rapid infiltration sites will degrade natural landscapes.
SOCIAL WELL BEING	Benefits:	**Municipal Services:** Sewer service areas support most community growth and development goals. **Recreation:** Recreational activities associated with visual improvement in water quality will increase.	**Recreation:** Water contact recreational activities: swimming, boating, fishing, etc., will increase in freshwater segments of the basin. **Municipal Services:** Sewer service areas generally compatible with regional land use plans. **Public Health:** Elimination of residual toxics will prevent their accumulation in finfish.	**Land Use:** Sewer service areas generally support regional land use plans. Waterfront property will increase in value. **Municipal Services:** Improved water quality of Merrimack River will increase its utility as a water supply source.	Same as Alternative #1.	Same as Alternative #1.	Same as Alternative #1.	**Municipal Services:** Land treatment systems generally less costly to operate and maintain. **Land Use:** Land treatment may be a tool for influencing growth and development patterns.	**Public Health:** Small land application systems properly managed and monitored would be more reliable than advanced waste treatment plants. **Recreation:** Potential multiple use at spray irrigation sites.	**Recreation:** Potential multiple use of spray irrigation sites.	**Recreation:** Water contact recreational activities will increase. Potential multiple use of treatment facilities. **Municipal Services:** Sewer service areas generally compatible with regional land use plans. Improved water quality of Merrimack River will increase its utility as a water supply source. Where appropriate, land treatment systems are generally less costly to operate and maintain. **Land Use:** Effective land use management plans for rural communities would reduce non-point sources of pollution.
	Costs:	**Public Health:** Failing on-lot septic systems will continue to degrade water quality of smaller tributaries. Finfish may continue to accumulate toxic substances beyond safe levels for human consumption.	**Transportation:** Local traffic patterns will experience short-term disruptions during construction.	**Municipal Services:** Sewer service systems would be constructed in rural towns that may not need them to solve potential future problems. Municipal services related to increased growth and development—water supply, schools, etc., will have to expand.	**Public Health:** Transmission systems are subject to leakage and pump failure creating potential health hazard. See Alternative #1.	**Public Health:** Transmission systems are subject to leakage and pump failures creating potential health hazards. **Transportation:** Extensive transmission systems will temporarily disrupt local traffic patterns.	**Recreation:** Reduced flows in certain river segments would effectively limit recreational opportunities during low flow periods. See Alternative #1.	**Public Health:** Detailed investigations are required before land treatment systems can be fully endorsed. Possible risk of groundwater contamination. **Transportation:** Local traffic patterns will experience short-term disruptions during construction.	**Land Use:** 2890 acres of land would be removed from tax roles. Potential sites for land treatment may conflict with local development plans. Land acquisition costs may be expensive.	**Land Use:** 2795 acres of land would be removed from tax roles. Potential sites for land treatment may conflict with local development plans.	**Municipal Services:** Services related to increased growth and development-water supply, schools, etc. will have to expand with expansion of sewer services. **Public Health:** Possible risk of groundwater contamination at rapid infiltration sites. **Transportation:** Local traffic patterns will experience short-term disruptions during construction. **Land Use:** 1400 acres of land would be removed from tax roles. Potential sites for land treatment may conflict with local development plans. Land acquisition costs may be expensive.
NATIONAL ECONOMIC DEVELOPMENT	Benefits:	**Manufacturing:** Minimal impact on local industry.				**Commercial Fisheries:** Discharge of advanced effluent to the estuary will increase possibilities of shellfish harvesting.	Same as Alternative #3.	**Agriculture:** Economic return on crops harvested from spray irrigation sites. Nutrient content of wastewater used as fertilizer.	**Agriculture:** Productivity of agricultural crops enhanced.	**Agriculture:** Same as Alternative #5.	**Agriculture:** Economic return on crops harvested from spray irrigation site. Nutrient content of wastewater utilized as fertilizer. Productivity of agricultural crops enhanced.
	Costs:	**Monetary Cost:** Estimated total project cost of State-EPA plan is $330 million.	**Manufacturing:** Stringent abatement actions necessary to comply with effluent standards will have an adverse impact on local industry & increase unemployment. Treatment plant operation will increase energy demands.	**Monetary Costs:** Estimated total project cost is $714 million. **Commercial Fisheries:** Discharge of secondary effluent to the estuary may prohibit shellfish harvesting.	**Monetary Costs:** Estimated total project cost is $726 million. **Commercial Fisheries:** Discharge of secondary effluent to the estuary may prohibit shellfish harvesting.	**Monetary Costs:** Estimated total project cost is $778 million.	**Monetary Costs:** Estimated total project cost is $766 million.	**Manufacturing:** Stringent abatement actions necessary to comply with effluent standards will have an adverse impact on local industry and increase unemployment.	**Monetary Costs:** Estimated total project cost is $803 million.	**Monetary Costs:** Estimated total project cost is $806 million.	**Manufacturing:** Stringent abatement actions necessary to comply with effluent standards will have an adverse impact on local industry and increase unemployment. **Monetary Costs:** Estimated total project cost is $722 million.
REGIONAL DEVELOPMENT	Benefits:	**Employment:** Construction of facilities and operation & maintenance requirements will create job opportunities.	**Municipal Services:** Service sector associated with increased recreational activities will markedly improve. **Employment:** Construction and operation & maintenance of treatment facilities will create increased labor opportunities.					**Municipal Service:** Service sector associated with increased recreational activities will markedly improve.	**Employment:** Construction and operation and maintenance of treatment systems will create increased labor opportunities.	Same as Alternative #5.	**Municipal Services:** Service sector associated with increased recreational activities will markedly improve. **Employment:** Construction and operation and maintenance of treatment facilities will create increased labor opportunities.
	Costs:	**Municipal Finance:** Local taxes will increase.	**Municipal Taxes:** Local taxes will increase significantly for some communities.	**Housing:** Local development pressures may arise with expansion of sewer services.	Same as Alternative #1.	Same as Alternative #1.	Same as Alternative #1.	**Municipal Taxes:** Local taxes will increase significantly for some communities.	**Housing:** Homes within potential land application sites would have to be relocated.	**Housing:** Homes within potential land application sites would have to be relocated.	**Municipal Taxes:** Local taxes will increase significantly for some communities.

IMPACT ASSESSMENT SUMMARY

TABLE 1



, The view from skylab



RECOMMENDED PLAN

FIG. 2

VI. WASTEWATER MANAGEMENT PLAN FOR NEW HAMPSHIRE

The New Hampshire Water Supply and Pollution Control Commission prepared and published a water quality management plan (Staff Report No. 56 and No. 61) in February 1972 and November 1973 which was pursuant to PL 92-500 Section 303e and the New Hampshire Continuing Planning Process. The purpose of this plan was to describe the necessary steps and actions required to restore and or maintain the chemical, physical and biological integrity of the waters of the Merrimack River Basin in New Hampshire in accordance with the goals set forth in PL 92-500, the Federal Water Pollution Control Act Amendments of 1972. The implementation of this plan will achieve the water quality standards set by the State of New Hampshire. In addition to meeting stream water quality standards, effluent limitations were set requiring all the establishments discharging wastes to these waters to provide such treatment as was technically and economically practicable.

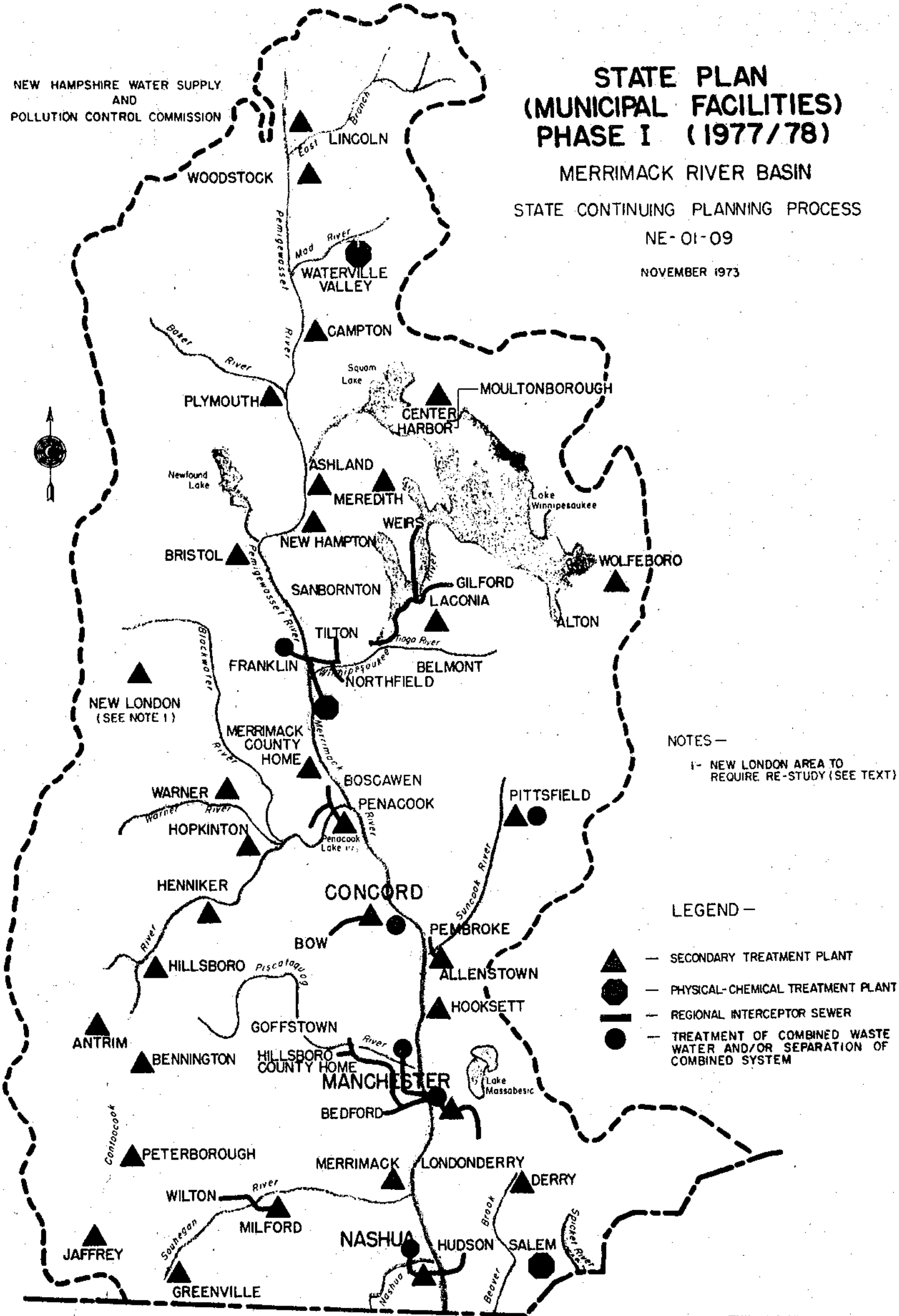
The plan involves two phases of implementation: Phase I addresses requirements set for July 1, 1977 by PL 92-500 as shown in Figure 3. Wastewater treatment required in Phase I, is a minimum of secondary treatment for all municipal waste and best practicable treatment for all industrial waste not passing through a municipal treatment facility.

The New Hampshire report calls for the implementation of small wastewater treatment facilities at various locations depicted on Figure 3. A partial listing of wastewater treatment facilities now serving 23 municipalities within the Merrimack River Basin in New Hampshire are shown in Table 2. This table indicates the type of treatment and costs associated with the particular facility.

Another 24 treatment facilities have not yet been completed but are either in the planning stages or final design (Table 3). Treatment technologies proposed include conventional secondary treatment methods as well as spray irrigation to agricultural and forested lands. In several communities, advanced wastewater treatment technologies are proposed.

Phase II of the New Hampshire state plan reflects the requirements of PL 92-500 for July 1, 1983, at which time all public-owned treatment works shall apply the best practicable waste treatment technology (BPT) as defined by EPA. BPT may be accomplished either by spray irrigation of treated waste to the land or other forms of advanced wastewater treatment. The Phase II state plan is shown in Figure 4. Phase II proposes upgrading of treatment systems proposed in Phase I to meet the water quality treatment requirements for 1983.

The following tables show that $40,019,681 worth of pollution control projects were completed as of November 1973, and that $167,640,000 worth of pollution control projects are in various stages of progress.



NEW HAMPSHIRE WATER SUPPLY AND POLLUTION CONTROL COMMISSION
STATE PLAN (MUNICIPAL FACILITIES) PHASE I (1977/78)
MERRIMACK RIVER BASIN
STATE CONTINUING PLANNING PROCESS
NE-01-09
NOVEMBER 1973
LINCOLN
WOODSTOCK
East Branch
Pemigewasset River
Mad River
WATERVILLE VALLEY
CAMPTON
Baker River
Squam Lake
MOULTONBOROUGH
CENTER HARBOR
PLYMOUTH
Newfound Lake
ASHLAND
MEREDITH
Lake Winnipesaukee
WEIRS
NEW HAMPTON
BRISTOL
WOLFEBORO
SANBORNTON
GILFORD
LACONIA
ALTON
TILTON
Tioga River
Winnipesaukee
FRANKLIN
BELMONT
NORTHFIELD
Blackwater River
NEW LONDON (SEE NOTE 1)
MERRIMACK COUNTY HOME
Merrimack River
BOSCAWEN
PENACOOK
Penacook Lake
WARNER
Warner River
HOPKINTON
PITTSFIELD
Suncook River
NOTES—
1- NEW LONDON AREA TO REQUIRE RE-STUDY (SEE TEXT)
HENNIKER
CONCORD
BOW
PEMBROKE
ALLENSTOWN
HILLSBORO
Piscataquog River
HOOKSETT
LEGEND—
— SECONDARY TREATMENT PLANT
— PHYSICAL-CHEMICAL TREATMENT PLANT
— REGIONAL INTERCEPTOR SEWER
— TREATMENT OF COMBINED WASTE WATER AND/OR SEPARATION OF COMBINED SYSTEM
ANTRIM
GOFFSTOWN
BENNINGTON
HILLSBORO COUNTY HOME
MANCHESTER
Lake Massabesic
BEDFORD
Contoocook
PETERBOROUGH
MERRIMACK
LONDONDERRY
DERRY
WILTON
MILFORD
Souhegan
JAFFREY
NASHUA
HUDSON
SALEM
Spicket River
Beaver Brook
Nashua
GREENVILLE

FIGURE 3

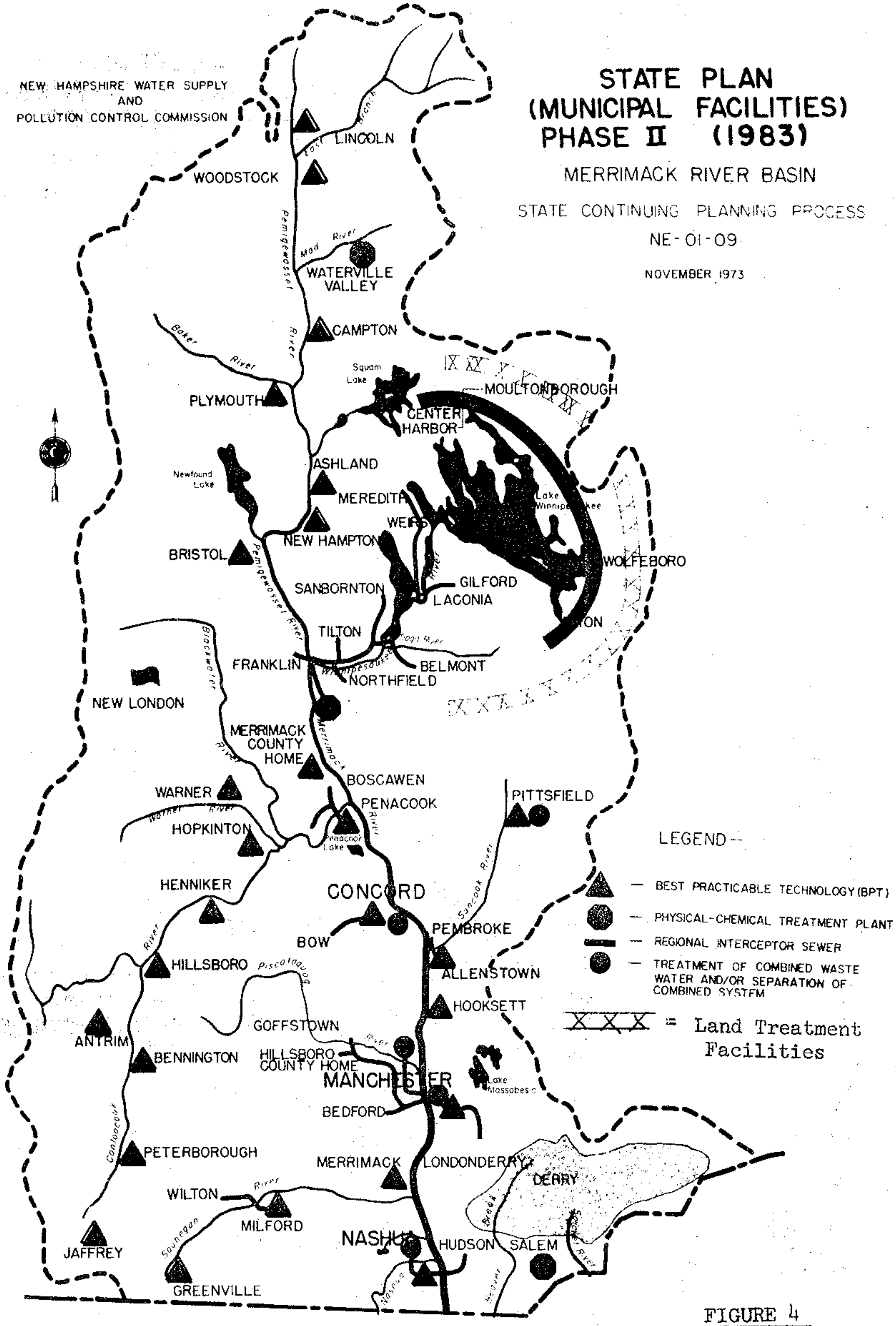

NEW HAMPSHIRE WATER SUPPLY AND POLLUTION CONTROL COMMISSION
STATE PLAN
(MUNICIPAL FACILITIES)
PHASE II (1983)
MERRIMACK RIVER BASIN
STATE CONTINUING PLANNING PROCESS
NE-01-09
NOVEMBER 1973
LEGEND--
— BEST PRACTICABLE TECHNOLOGY (BPT)
— PHYSICAL-CHEMICAL TREATMENT PLANT
— REGIONAL INTERCEPTOR SEWER
— TREATMENT OF COMBINED WASTE WATER AND/OR SEPARATION OF COMBINED SYSTEM
XXX = Land Treatment Facilities
LINCOLN
WOODSTOCK
WATERVILLE VALLEY
CAMPTON
PLYMOUTH
MOULTONBOROUGH
CENTER HARBOR
ASHLAND
MEREDITH
WEIRS
NEW HAMPTON
BRISTOL
SANBORNTON
GILFORD
LACONIA
WOLFEBORO
TILTON
FRANKLIN
BELMONT
NORTHFIELD
NEW LONDON
MERRIMACK COUNTY HOME
BOSCAWEN
WARNER
PENACOOK
PITTSFIELD
HOPKINTON
HENNIKER
CONCORD
BOW
PEMBROKE
HILLSBORO
ALLENSTOWN
HOOKSETT
GOFFSTOWN
ANTRIM
BENNINGTON
HILLSBORO COUNTY HOME
MANCHESTER
BEDFORD
PETERBOROUGH
MERRIMACK
LONDONDERRY
DERRY
WILTON
MILFORD
NASHUA
HUDSON
SALEM
JAFFREY
GREENVILLE
Pemigewasset River
Baker River
Mad River
Merrimack River
Blackwater River
Warner River
Contoocook River
Piscataquog River
Souhegan River
Suncook River
Squam Lake
Newfound Lake
Lake Winnipesaukee
Penacook Lake
Lake Massabesic

FIGURE 4

TABLE 2

POLLUTION CONTROL PROJECTS COMPLETED IN MERRIMACK RIVER BASIN, NEW HAMPSHIRE (November, 1973)

LOCATION	TYPE TREATMENT	COST BREAKDOWN FEDERAL	STATE	LOCAL	TOTAL
Ashland	Secondary	659,300	527,440	268,000	1,454,740
Bristol	Secondary	258,990	188,396	569,172	1,016,558
Campton	Secondary	---	---	204,860	204,860
Center Harbor Moultonborough	Secondary	120,096	177,734	102,493	400,323
Derry	Secondary	185,862	304,286	1,548,655	2,038,803
Goffstown	Primary	86,220	118,798	113,582	318,600
Hillsborough County Home	Primary	25,500	32,277	45,223	103,000
Hooksett	Secondary	1,117,284	893,828	388,888	2,400,000
Jaffrey	Secondary	408,041	365,491	238,468	1,012,000
Laconia	Primary	1,130,366	1,619,220	2,055,156	4,804,742
Lincoln	Secondary	459,235	323,090	39,901	822,226
Lincoln Franconia Mfg. Co.	Primary	1,626,683	1,504,382	725,950	3,857,015
Meredith	Secondary	15,900	96,829	143,364	256,093
Merrimack	Secondary	4,169,000	3,335,200	2,273,333	9,777,533
Nashua	Primary	919,717	1,146,817	1,344,480	3,411,014
New Hampton	Secondary	30,054	87,562	22,384	140,000
New London*	Secondary	---	7,846	14,259	22,105
Peterborough	Secondary	1,399,200	1,017,600	950,559	3,367,359
Plymouth	Primary	525,212	309,399	344,389	1,179,000
Salem	Secondary	804,625	852,728	689,088	2,346,441
Waterville Valley	Secondary	---	---	100,000	100,000
Wolfeboro*	Primary	---	23,156	38,595	61,751
Woodstock	Secondary	392,590	314,072	218,856	925,518
	Sub-total	14,333,875	13,246,151	12,439,655	
			GRAND TOTAL		40,019,681

*Treatment plant was completed before the Federal-State Construction grants program was instituted, hence, the costs shown do not accurately reflect the monies which have been invested by the municipality.

TABLE 3

POLLUTION CONTROL PROJECTS IN PROGRESS IN MERRIMACK RIVER BASIN, NEW HAMPSHIRE (November, 1973)

LOCATION	PROPOSED TREATMENT	PROJECT PHASE	COMPLETION DATE	ESTIMATED COST ALLOCATION FEDERAL	STATE	LOCAL	TOTAL
Alton	Secondary & Spray Irrigation	Design	1979	1,750,000	625,000	625,000	3,000,000
Allenstown, Pembroke	Secondary	Design	1974	2,660,000	950,000	1,090,000	4,700,000
Bennington, Antrim	Secondary	Designed	1975	1,750,000	625,000	1,225,000	3,600,000
Boscawen (Merrimack County Home)	Secondary	Designed	1975	157,500	56,250	11,250	225,000
Center Harbor & Moultonboro	Secondary & Spray Irrigation	Planning	1979	1,400,000	500,000	100,000	2,000,000
Concord (North) Penacook, Boscawen	Secondary	Construction	1974	4,225,000	1,495,000	780,000	6,500,000
Concord (South) Bow	Secondary	Report	1977	7,910,000	2,825,000	1,665,000	12,400,000
Derry & South Londonderry	Secondary	Report	1977	5,180,000	1,850,000	1,870,000	8,900,000
Franklin, Tilton, Northfield, Belmont, Sanbornton, Laconia, Gilford, Meredith	Advanced Wastewater Treatment	Report	Phase I 1974 Phase II 1978 Phase III 1982	23,180,500	8,278,750	1,655,750	33,115,000
Henniker	Secondary	Designed	1975	980,000	350,000	370,000	1,700,000
Hillsborough	Secondary	Designed	1975	1,050,000	375,000	375,000	1,800,000
Hopkinton	Secondary	Report	1976	1,120,000	400,000	380,000	1,900,000
Lincoln (Franconia Manufacturing Co.)	Equivalent Secondary	Planning	1975	1,000,000		1,000,000	2,000,000

TABLE 3 (Cont'd)

LOCATION	PROPOSED TREATMENT	PROJECT PHASE	COMPLETION DATE	ESTIMATED COST ALLOCATION FEDERAL	STATE	LOCAL	TOTAL
Manchester, Bedford, North Londonderry	Secondary	Design	1975	25,200,000	9,000,000	1,800,000	36,000,000
Milford, Wilton	Secondary	Report	1978	5,110,000	1,825,000	1,665,000	8,600,000
Nashua, Hudson	1) Primary Expansion	Designed	1975	9,800,000	3,500,000	700,000	14,000,000
	2) Secondary	Report		1,000,000	2,800,000	200,000	4,000,000
New London	Tertiary	Planning	1977	5,600,000	2,000,000	5,400,000	13,000,000
Pittsfield	Secondary	Design	1975	1,960,000	700,000	840,000	3,500,000
Plymouth	Secondary	Planning	Dec. 1975	1,050,000	375,000	75,000	1,500,000
Salem	Addition to Existing Secondary	Designed	1974	105,000	37,500	7,500	150,000
Warner	Secondary	Designed	1975	420,000	150,000	230,000	800,000
Waterville Valley	Advanced Wastewater Treatment	Design	1973	525,000	187,500	37,500	800,000
Wolfeboro	1) Secondary	Design	1974	1,120,000	400,000	80,000	1,600,000
	2) Spray Irrigation	Planning		1,330,000	475,000	95,000	1,900,000
	Sub-totals			105,583,000	39,780,000	22,277,000	
				GRAND TOTAL			167,640,000

VII. NASHUA RIVER PROGRAM STUDY

A. Introduction

Concurrent to the Corps of Engineers wastewater management planning efforts in the mainstem region of the Merrimack River and the Boston Metropolitan area, the Nashua River Program, under the supervision of the New England Interstate Water Pollution Control Commission, conducted a wastewater management study in the Nashua River Basin. The study was funded by the New England Regional Commission but was carried out by the Nashua River Program and the New England Interstate Water Pollution Control Commission.

The report for this study was prepared by the New England Interstate Water Pollution Control Commission and the Nashua River Program and is titled: "Water Quality Management Plan - Nashua River Basin," dated December 1975.

B. Study Objectives and Scope

The objective of this study was to propose regional wastewater treatment alternatives which would achieve stream standards as set in the Nashua River Basin by the Commonwealth of Massachusetts, and the State of New Hampshire and thereby address the 1983 goals of PL 92-500 and develop for the Nashua River Basin a comprehensive regional water quality management plan and implementation program for the foreseeable future. This comprehensive plan would form a basis upon which additional studies of a more detailed nature could be made for proposed water quality improvement projects within the study area. The preparation of the study report is in its final stages and publication of the final report is tentatively scheduled for late 1975 or early 1976.

The scope of this study included: a detailed stream and sediment survey and analysis; a thorough evaluation of existing water quality, a thorough evaluation of previously prepared regional studies; development of the Nashua River Model which was utilized to evaluate current water quality management plans and was used as a basis for recommendations contained in this study; a recommended water quality management plan including priorities and implementation stages; development of possible institutional and financial arrangements; assessment of biological, social, economic and hygienic impacts; and development of a public participation program to provide for citizens' input.

C. Study Area and Local Jurisdictional Background

The Nashua River Basin encompasses an area of 529 square miles within the States of Massachusetts and New Hampshire. The basin includes portions of three counties: Worcester and Middlesex Counties in Massachusetts and Hillsborough County in New Hampshire. The state agencies responsible for water pollution abatement efforts have been actively involved in the basin; these are the Massachusetts Division of Water Pollution Control and the New Hampshire Water Supply and Pollution Control Commission.

The preparation of plans for water quality management in the basin has been accomplished by entities at two levels of government: the municipalities and the regional planning agencies. The municipalities included in the present study lie within the jurisdiction of five regional planning agencies; namely, the Central Massachusetts, Montachusett, Nashua and Northern Middlesex Regional Planning Commissions and the Metropolitan Area Planning Council.

D. Recommended Wastewater Management Plan

The wastewater management alternatives considered in the Nashua River Basin were those which would achieve the 1983 water quality of best practicable treatment as defined by the Environmental Protection Agency. The proposed locations of the recommended water pollution abatement facilities are shown on Figure 5, prepared by the Nashua River Program.

Information on population served, wastewater flows and preliminary costs associated with the proposed regional facilities in Massachusetts are shown on Table 4 for each community joined to the proposed regional treatment facility.

The approximate construction cost of the plan in the Massachusetts portion of the basin is $67,700,000 and $18,000,000 in the State of New Hampshire.

The plan has been coordinated with the Commonwealth of Massachusetts and the State of New Hampshire as well as the Environmental Protection Agency. It calls for regional treatment facilities along the Nashua River in the Towns of Ayer, Clinton and Pepperell; along the North Nashua River in East and West Fitchburg and Leominster. Various towns along the southern border of the drainage basin would discharge to facilities in Millbury, Massachusetts Upper Blackstone Pollution Abatement District, which is outside of the basin. The City of Nashua plant would receive wastewater from two other nearby New Hampshire towns and the flows from that regional plant would discharge into the Merrimack River instead of the Nashua River. The plan also calls for the continuance of private on-lot disposal facilities in certain towns where conditions are suitable and the systems will operate properly.

E. Summary

Based on the report, it is apparent that the river is seriously polluted throughout its entire length primarily due to the discharge of municipal and industrial wastes from the Cities of Fitchburg and Leominster. The effects of these discharges continue downstream for about 40 miles to Pepperell Pond.

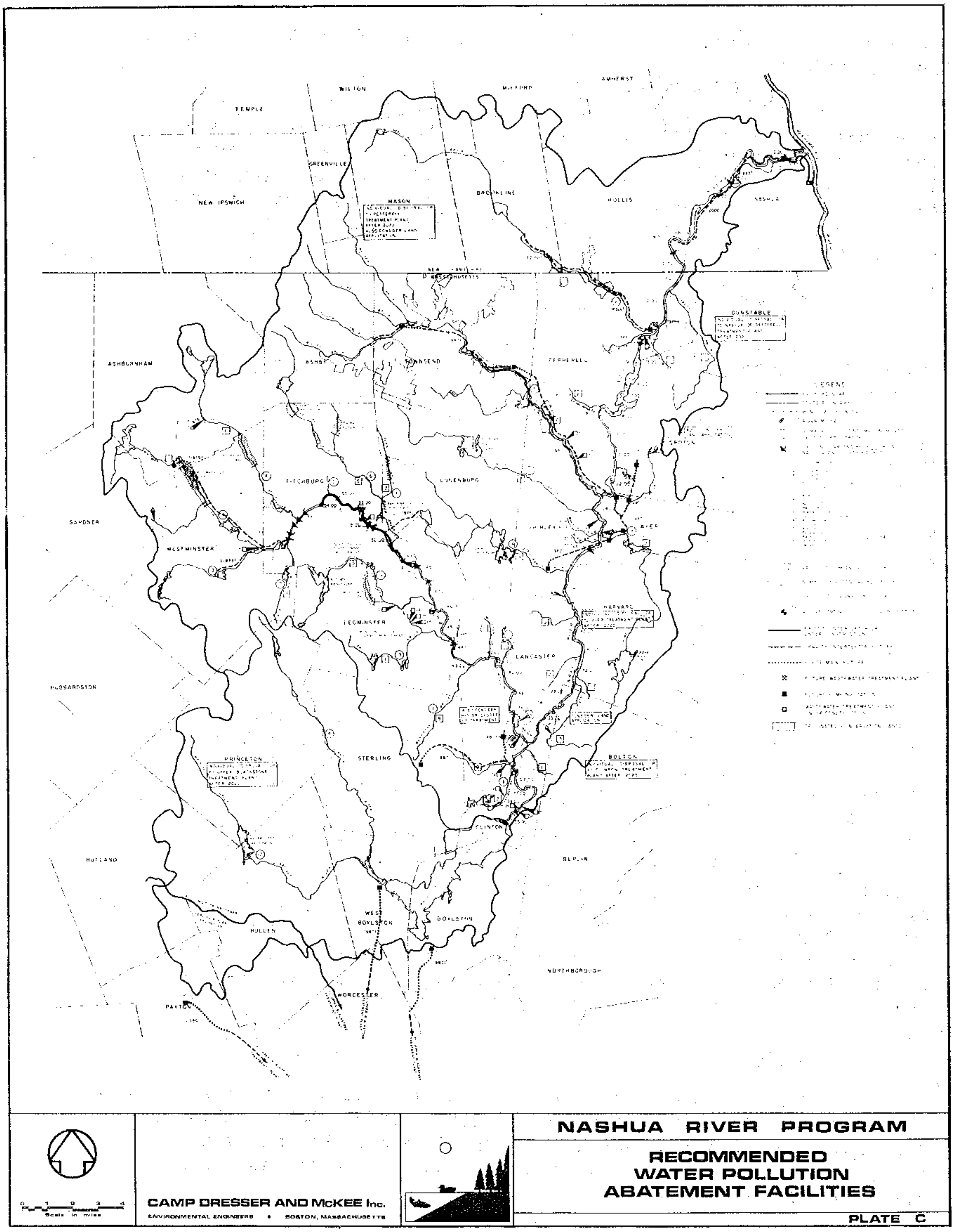

NASHUA RIVER PROGRAM
RECOMMENDED
WATER POLLUTION
ABATEMENT FACILITIES
PLATE C
CAMP DRESSER AND McKEE Inc.
ENVIRONMENTAL ENGINEERS • BOSTON, MASSACHUSETTS
FITCHBURG
LEOMINSTER
LANCASTER
CLINTON
STERLING
NASHUA
WEST BOYLSTON
BOYLSTON
WORCESTER
PRINCETON
HUBBARDSTON
RUTLAND
GARDNER
ASHBURNHAM
WESTMINSTER
ASHBY
TOWNSEND
PEPPERELL
GROTON
AYER
HARVARD
BOLTON
BERLIN
NORTHBOROUGH
HOLDEN
PAXTON
DUNSTABLE
HOLLIS
BROOKLINE
MASON
NEW IPSWICH
GREENVILLE
TEMPLE
WILTON
MILFORD
AMHERST
LUNENBURG
SHIRLEY

FIGURE 5

The study indicates an immediate need to implement a program of constructing water pollution abatement facilities, separation of combined collection systems in Fitchburg and Leominster, and adoption of land use plans, all of which are essential and a prerequisite to good water quality management.

Nonpoint sources of pollution are also very evident and must be further addressed in the near future and in more detail, especially in the ongoing 208 studies.

TABLE 4

Population Sewered, Costs, and Wastewater Flows for Proposed Regional Wastewater Treatment Facilities in Nashua River Basin - Massachusetts 1/

	Population Sewered			Cost	Wastewater Flows (MGD)		
	1975	1990	2020	(x$1000) 2/	1975	1990	2020
Fitchburg West STP							
Ashburnham	1433	2215	5264	2334(A)	0.09	0.17	0.51
Westminster	1853	3079	7964	1722	0.41	0.56	1.56
West Fitchburg (includes paper mills)	897	3524	6900	13018	13.79	14.65	15.67
Fitchburg East STP							
Lunenburg	1610	4232	16522	1081	0.08	0.26	1.38
Fitchburg	40630	36820	36749	14922	9.41	11.22	13.99
Leominster STP 3/	29412	37930	47961	17000*	7.68	9.19	11.51
Clinton STP							
Clinton	13030	13026	15119	5100	2.02	2.34	3.22
Lancaster	3185	4493	10304	93	0.30	0.49	1.23
Sterling	0	1553	6957	67	0	0.11	0.57
Bolton	0	0	1729	N.C.	0	0	0.17
Ayer STP							
Ayer	5345	9436	17000	8790	0.90	1.56	2.79
Shirley	0	3495	5835	(A)	0	0.27	0.60
Groton	0	2923	9413	(A)	0	0.24	0.93
Townsend	0	4202	7076	(A)	0	0.26	0.56
Ashby	0	0	2453	(A)	0	0	0.20
Pepperell STP							
Pepperell	3270	5813	10000	1317	0.33	0.58	1.00
Dunstable	0	0	1426	(A)	0	0	0.14
Upper Blackstone STP							
Rutland	1869	3531	5701	37	0.24	0.45	0.84
Holden	9176	17602	24255	164	1.32	2.39	3.93
West Boylston	0	7700	11800	1440	0	1.37	2.07
Boylston	0	3764	5728	691	0	0.54	0.90
TOTALS	111,710	165,338	256,161	67,776	36.57	46.65	63.79

1. From Chapter 12 Wastewater Management Report for Nashua River, under direction of New England Interstate Water Pollution Control Commission, Boston, Massachusetts (in progress).

2. Includes cost of treatment facility and interceptors. Most facilities are based on 1990 flows and on present worth costs.

3. Present 201 study will determine specific costs of reconstruction as well as flows. Possible connection of North Leominster to Fitchburg East STP.

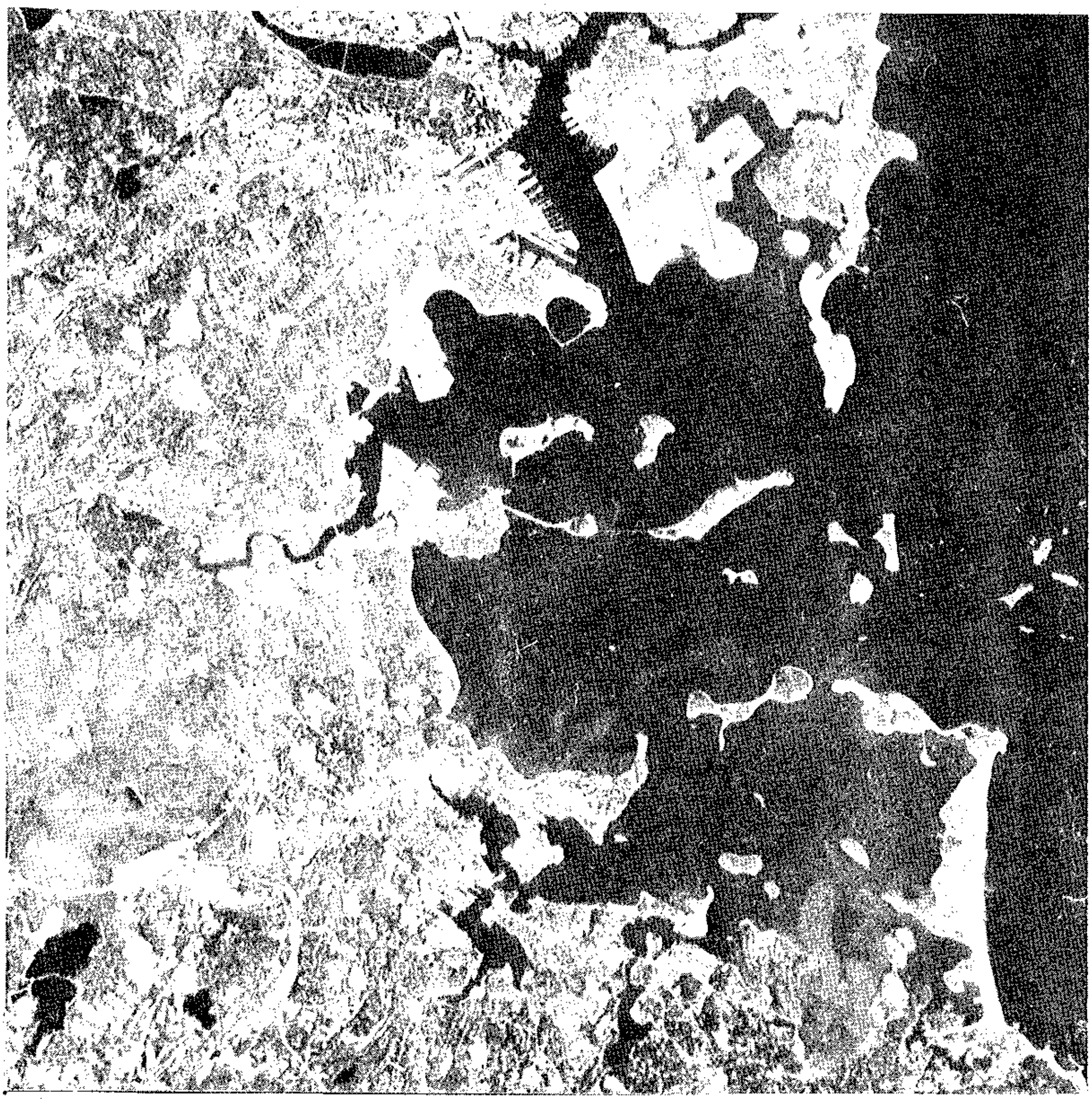
4. Population, wastewater flows and costs for the Fort Devens facilities are not included as they are not proposed for inclusion in any regional system at this time.

N.C. - Not costed

(A) - Cost to be negotiated

* Preliminary Cost - Not approved

Note: The estimated construction cost of expanding primary treatment facilities and adding regional secondary treatment facilities to the Nashua, New Hampshire primary treatment plant is approximately $18,000,000.



SKY LAB PHOTO OF BOSTON

VIII. BOSTON HARBOR-EASTERN MASSACHUSETTS METROPOLITAN AREA WASTEWATER MANAGEMENT STUDY (October 1975)

A. Introduction

1. Background

The authority for the Corps of Engineers' participation in the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study is contained within resolutions of the Public Works Committees of the U.S. Senate and House of Representatives dated 2 March and 14 June 1972, respectively. These resolutions authorized the Secretary of the Army, acting through the Chief of Engineers, to cooperate with the Commonwealth of Massachusetts in conducting a joint study to recommend improvements in wastewater management and alternatives thereto within the Boston Metropolitan area. The scope of the study was to be established in consultation with the Commonwealth of Massachusetts and the Environmental Protection Agency and was to include measures for wastewater management including cleanup and restoration in the interest of water supply, environmental quality, recreation, and fish and wildlife and was to incorporate the overall water resources and wastewater management implementation program previously determined by the Commonwealth of Massachusetts and approved by the Environmental Protection Agency. The cost of the study was approximately $2,200,000 with approximately equal funding by the Commonwealth of Massachusetts and the Corps of Engineers.

On 24 May 1972, the Commonwealth of Massachusetts and the Environmental Protection Agency signed an agreement relative to the Boston Metropolitan area. The agreement included the following items:

- Accomplish comprehensive engineering and management studies leading to a provision of a minimum of secondary treatment for all wastes discharged from the Metropolitan District Commission's Deer and Nut Island treatment plants by May 1, 1979.

- Investigate possible expansion of the MDC region, changes in structure, charges for wastewater treatment, methods of capital financing and possibilities of associated wastewater reclamation for such purposes as maintenance of minimum flow in streams throughout the Metropolitan Boston area.

- Meet requirements of Title 18 C.F.R. Section 601.25(b) dated July 8, 1971 for all wastes discharged from the MDC treatment plants.

- Prepare engineering alternatives for handling of sludges generated from the MDC treatment plants.

A time schedule was established in the agreement for accomplishing the various requirements:

. 1 August 1972 - Commonwealth to commit sufficient funds to conduct the engineering and management studies.

. 1 October 1972 - Execute contract with a nationally known professional engineering consulting firm to conduct said engineering and management studies.

. 1 November 1972 - 1 April 1974 - Commonwealth to forward interim progress reports to EPA with respect to said engineering and management studies.

. 1 April 1974 - Complete engineering and management studies and deliver copies to EPA for review.

. 1 July 1974 - Complete EPA and Commonwealth analysis of said engineering study, adopt action plan, including detailed schedule for constructing the necessary facilities to provide a minimum of secondary treatment for all wastes discharged from the MDC treatment plants.

. 1 August 1974 - Commonwealth to commit sufficient funds to prepare engineering design and construction plans of the necessary facilities.

. 1 January 1976 - Complete engineering design, and construction plans and specifications for the facilities to provide a minimum of secondary treatment for all wastes discharged from the MDC treatment plants.

. 1 March 1976 - Commonwealth to commit sufficient capital funds to construct the necessary facilities.

. 1 May 1976 - Commence construction of the initial projects.

. 1 May 1979 - Complete initial projects, including constructing facilities to provide a minimum of secondary treatment for all wastes discharges from the MDC's Deer and Nut Island plants, and

. 31 December 1980 - Complete construction and achieve full operation of all other new or expanded plants so as to provide a minimum of secondary treatment for all wastes discharged from the MDC treatment plants.

The Commonwealth proceeded in accordance with the agreement and after the Commonwealth's 1972 Environmental Capital Outlay Program was approved, the Metropolitan District Commission initiated selection and negotiation procedures with several consulting firms.

On 27 November 1972, an agreement was executed between the Commonwealth of Massachusetts and the Corps of Engineers to undertake a joint study. The agreement said in part:

"The wastewater plan will aim at thorough elimination of pollutants through the use of both basic and advanced treatment and disposal techniques and other approaches."

"The planning effort will be conducted as a single operation, composed of both Federal and State personnel, having an integrated Federal-State decision process, and resulting in a joint report."

2. Organization

In August 1972, the Metropolitan District Commission invited the Corps of Engineers to collaborate with them in selecting their consultant and in working out the scope of services to accomplish the study. Through this series of meetings, the elements of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study and a management organization were agreed upon.

In 1972, the Commonwealth of Massachusetts established a cabinet level State Policy Committee for Water Quality Management Planning. This committee established from its component agencies a State Technical Committee. For reasons of uniformity and overall management within the Commonwealth of Massachusetts, the management entity for the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study was established within this framework. This organization is illustrated in Figure 6. The Technical Subcommittee on Boston Harbor was initially composed of the Metropolitan District Commission, Chairman; the Corps of Engineers; the Environmental Protection Agency; the Massachusetts Division of Water Pollution Control; the Massachusetts Office of State Planning and Management; and the Metropolitan Area Planning Council. Subsequently, the Massachusetts Department of Public Health and a Citizens' Group were invited to join. The Office of State Planning and Management became, over time, the Resources Management Policy Council and ultimately the Office of State Planning.

The Technical Subcommittee was formed on the premise that it would reach decision by concensus. As the study evolved, the concensus approach was acceptable in most cases. When decisions could not be reached by concensus, the Technical Subcommittee fell back to a position of majority rule.

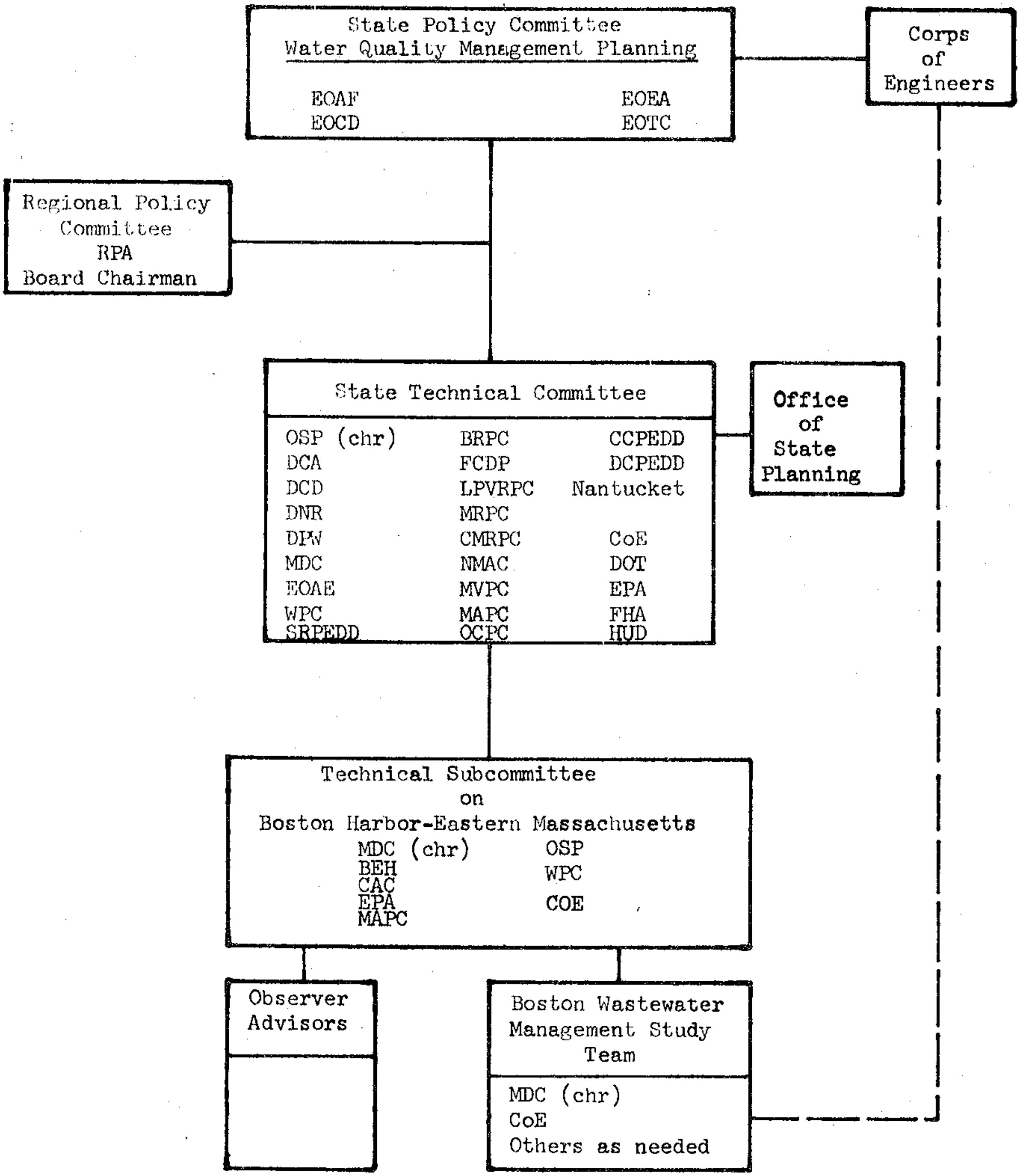
B. Goals and Objectives

1. National Goals

The Federal Water Pollution Control Act Amendments became Public Law 92-500 (PL 92-500) on October 18, 1972. The primary

BOSTON HARBOR-EASTERN MASSACHUSETTS METROPOLITAN AREA
WASTEWATER MANAGEMENT STUDY

ORGANIZATION CHART



----indicates staff support of Corps personnel

FIGURE 6

objective of this law is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." To achieve this objective, two general goals are stated:

(1) To achieve, wherever possible by July 1, 1983, water quality which provides for the protection and propogation of fish, shellfish and wildlife, and provides for recreation in and on the water.

(2) To eliminate, by 1985, discharge of pollutants into all navigable waters.

Public Law 92-500 sets up four major systems of planning - municipal, areawide, state and regional - to facilitate and coordinate achievement of these goals.

Section 201

Section 201 of the law requires that a facility plan be developed for all proposed publicly-owned treatment works applying for Federal funds authorized by the Act to assure that these treatment works are both environmentally sound and cost-effective.

As a minimum, all Federally funded waste treatment facility plans are to (1) provide for the application of best practicable waste treatment technology before any discharge to receiving waters; (2) take into account and allow, to the extent practicable, the application of technology at a later date which will provide the reclaiming or recycling of water or otherwise eliminate the discharge of pollutants; and (3) be coördinated with areawide waste treatment management plans, required by Section 208 of Public Law 92-500.

Section 208

Section 208 of the law requires that areawide waste treatment management plans be developed by planning agencies designated by the Governor of each state for specified areas where urban-industrial concentrations have caused major water quality control problems. These plans are to set forth a comprehensive management program for collection and treatment of wastes and for controlling pollution from all point and non-point sources.

Section 303e

Section 303e of the law requires that each state develop a continuing planning process consistent with the goals of the Act. Under the State continuing planning process, each state must monitor segments of waterways to classify each segment into one of two categories.

(1) Water Quality Limited - in which conditions of the water preclude attainment of the water quality standard even if all point sources provide the levels of treatment prescribed by Federal effluent guidelines. Federal guidelines require that all publicly-owned sewage treatment plants provide a minimum of secondary treatment by July 1, 1977 and "best practicable" treatment by July 1, 1983.

(2) Effluent Limited - in which the water quality standard is now being met or there is reasonable assurance that such a standard will be met by the application of Federal effluent guidelines.

States must develop basin plans for individual basins, specifying precise discharge limitations on point sources discharging to Water Quality limited segments of the basin, and designating construction priorities for waste treatment works needed to assure achievement of water quality standards in the basin.

Section 209

Section 209 of the law establishes "Level B" plans, to be conducted by both Federal and State agencies and intended to relate water pollution control and water resource management efforts on a river basin basis.

The Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study (BH-EMMA) recognizes the goals and objectives of Public Law 92-500 through addressing the requirements of Section 201 of the Act. The results of the study will constitute a facility plan for the Boston Metropolitan area, and will be coordinated with the area's 208 planning process.

The evolution of study goals and objectives is described in the following section.

2. Technical Subcommittee Goals and Objectives

At the outset of the study, agreements were signed between the Commonwealth of Massachusetts and two Federal agencies: the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. On May 24, 1972, prior to the passage of Public Law 92-500, the Environmental Protection Agency and the Commonwealth of Massachusetts signed an agreement requiring the Commonwealth to undertake a comprehensive engineering and management study to determine the most feasible means of achieving a minimum of secondary treatment at all wastewater treatment facilities in the Boston Metropolitan region; to determine engineering alternatives for handling sludges generated by MDC treatment facilities; and to develop a management program taking into consideration changes in management structure, rate structure, user charges and methods of capital financing. Significant dates established by the agreement were:

. May 1, 1979 - Completion of construction of facilities to provide a minimum of secondary treatment for wastes discharged from the MDC's Deer and Nut Island plants.

. December 31, 1980 - Completion of construction and achievement of full operation of all other new and expanded facilities to provide a minimum of secondary treatment for all wastes discharged from MDC treatment plants.

. May 1, 1976 - Elimination of sludge discharges to Boston Harbor.

In November 1972, the U.S. Army Corps of Engineers entered an agreement with the Commonwealth of Massachusetts to undertake a joint study to develop a wastewater management plan aimed at "thorough elimination of pollutants through the use of both basic and advanced treatment and disposal techniques and other approaches."

The objectives stated in these agreements differ as one was signed prior to and one was signed after the passage of Public Law 92-500.

In the fall of 1972, a Technical Subcommittee of various Federal, State and regional agencies was established for the BH-EMMA study. One of the subcommittee's first tasks was to establish study goals and objectives. Each agency was asked for input. The U.S. Environmental Protection Agency recommended that the study develop specific conclusions and recommendations for actions, and lead to the implementation of wastewater management plans that will:

a. Meet water quality standards by 1977 throughout the study area.

b. Achieve wherever attainable a water quality sufficient for recreation in and on the water as well as propogation of fish, shellfish and wildlife by 1983.

c. Encourage solutions that will lead to the elimination of pollutants and stress wastewater reuse and renovation.

d. Result in preliminary plans and engineering studies meeting the requirements of Section 201 of Public Law 92-500.

The U.S. Army Corps of Engineers recommended the goal stated in its agreement with the Commonwealth: "thorough elimination of pollutants." This goal is essentially the 1985 goal of PL 92-500.

The Metropolitan Area Planning Council suggested its regional goals and objectives:

a. <u>Housing</u> - "A decent home and a healthy living environment for every resident of the Metropolitan Boston region."

b. <u>Economic</u> - "Assurance of the economic well-being of all residents by maintaining and enhancing the economic competitive position of the Metropolitan Boston area in relation to the national economy and providing for an efficient geographic distribution of employment throughout the region."

c. <u>Environmental</u> - "Establishment of a physical environment that is well ordered, efficient, varied as to man-made and natural features, and meets the aesthetic, health, and recreation needs of all citizens."

d. <u>Transportation</u> - "Provide for the safe, convenient travel of the general public by means of integrated, intermodal transportation systems."

Although all these goals are not directly related to water quality, and could not be used as specific study goals, they were later used as input to the EMPIRIC land use allocation used to develop small area projections of population, employment and land use for the study area for the years 1990, 2020 and 2050.

Specific study goals, recommended by the Metropolitan District Commission, and later accepted by the entire Technical Subcommittee, were:

a. To develop recommendations for the management of wastewater in Eastern Massachusetts up to the year 2050.

b. To determine the ultimate growth or contraction of the Metropolitan Sewerage District (MSD) to the year 2050. All engineering, economic and environmental aspects to be considered, including the river basin concept.

c. To make recommendations for a management organization for the MSD and its subregional districts as may be projected. Administrative structure, policies, financial arrangements, and related management matters to be considered.

d. To determine facilities required for the collection, treatment, and disposal of existing and future MSD sewage flows including the preparation of preliminary engineering designs for the recommended method of treatment for the Deer Island and Nut Island projected sewage flows.

e. To make recommendations for the regulation of combined sewage overflows, infiltration and storm water with respect to both the MSD system and the systems of its member communities.

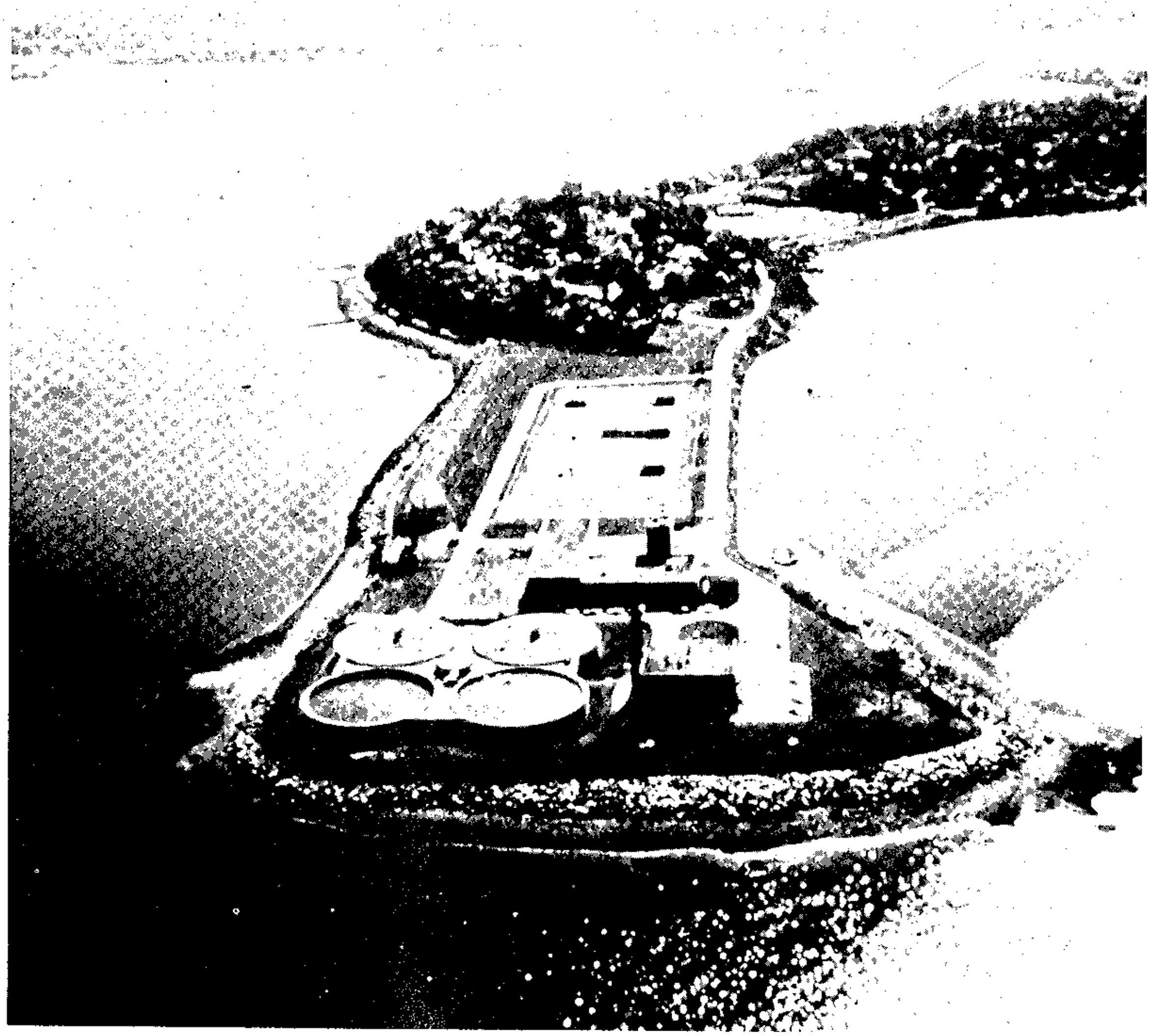
f. To undertake an industrial waste survey and inventory including developing industrial waste regulations and an equitable cost recovery system.

g. To determine the feasibility of reclamation and reuse of wastewater and treated water.

h. To develop short-range construction programs and detailed plans for facilities required by the year 2000.

i. To develop a public participation program throughout the duration of the study.

j. To meet the requirements of Section 201 of Public Law 92-500.



NUT ISLAND SEWERAGE TREATMENT PLANT

C. Task Assignments

Inasmuch as the Metropolitan District Commission was in the process of negotiating with private firms to accomplish those items designated in the Commonwealth of Massachusetts-EPA agreement when the Corps of Engineers joined the effort, the Technical Subcommittee of the BH-EMMA Study decided that the Corps of Engineers' efforts should supplement those items which the Metropolitan District Commission was to accomplish. The items that were to be addressed by the Metropolitan District Commission were as follows:

a. Development of basic data for the study area.

b. Establishing limits and systems for Eastern Massachusetts Metropolitan Area.

c. Preliminary engineering plan for additional treatment of Deer and Nut Islands' flows - pump stations and headworks.

d. Operation and regulation of sewage interceptors and overflows.

e. Industrial waste ordinance.

f. Management study.

g. Progress and final report of conclusions.

The Corps of Engineers' input to the study effort was designed to both supplement those items being addressed by the Metropolitan District Commission and satisfy Congressional directives. The major items that were to be addressed by the Corps included:

a. Public participation and information program

b. Land treatment alternatives

c. Industrial waste survey

d. Impact analysis and evaluation

e. Stormwater and urban runoff

Figure 7 is a graphic display of the division of tasks between the Corps of Engineers and the Metropolitan District Commission. Table 5 shows the role of all agencies on the Technical Subcommittee in accomplishment of study tasks.

BOSTON-EASTERN MASSACHUSETTS METROPOLITAN AREA
WASTEWATER MANAGEMENT STUDY
SUMMARY OF STUDY TASKS

PLANNING PHASES

GOALS, OBJECTIVES & CRITERIA — I & II

INTRODUCTION
GOALS & OBJECTIVES
PLANNING CRITERIA &
PUBLIC PARTICIPATION
BY
MDC & C OF E

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FIGURE 7

TABLE 5

**BOSTON HARBOR-EASTERN MASSACHUSETTS METROPOLITAN AREA
WASTEWATER MANAGEMENT STUDY
SUMMARY OF STUDY TASKS
AND
ASSIGNMENTS**

TASK	RESPONSIBLE AGENCY AND MAJOR EFFORT	MAJOR INPUT AGENCIES	FUNDING AGENCY	ROLE OF TECHNICAL SUBCOMMITTEE
PUBLIC PARTICIPATION				
Development of the Public Participation Program	Corps	MDC MAPC CAG	Corps	Advise & Assist
Public Meetings	Corps	MDC CAG	Corps	Advise & Assist
Brochures and Newsletters	Corps	MDC	Corps	Advise
Coordination with the News Media	Corps	MDC	Corps	Advise & Assist
DEVELOPMENT OF BASIC DATA				
Demographic & Economic Activity & Land Use	MDC	MAPC	MDC	Review & Comment
Climatology, Hydrology, Geology & Biota	Corps		Corps	Review & Comment
Industrial Waste Survey	Corps	MDC WPC	Corps	Assist & Review
Water Use & Consumption, Waste Loads, Sewer System, Infiltration & Existing Treatment Facilities	MDC		MDC	Assist & Review
Water Quality	Corps WPC	MDC DPH	Corps MDC	Assist & Review
DEVELOPMENT OF ENGINEERING ALTERNATIVES				
Water-Oriented	MDC	WPC DPH Corps	MDC	Assist & Review
Land-Oriented	Corps	MDC WPC DPH	Corps	Assist & Review
Sludge Treatment, Reuse and Disposal	Corps MDC	WPC DPH	Corps MDC	Assist & Review
Reuse of Effluent	Corps MDC	WPC DPH	Corps MDC	Assist & Review
Operation & Maintenance Requirements	Corps MDC	WPC	Corps MDC	Assist & Review
Cost Estimates	Corps MDC	WPC	Corps MDC	Assist & Review
COMBINED SEWER OVERFLOWS	MDC	WPC	MDC	Review & Comment
STORMWATER AND URBAN RUNOFF	Corps		Corps	Review & Comment
DEVELOPMENT OF INSTITUTIONAL & FINANCIAL ALTERNATIVES	MDC	OSP MAPC	MDC	Review & Comment
IMPACT ANALYSIS AND EVALUATION				
Socio-Economic, Biological, Hygienic, Aesthetic Impact	Corps		Corps	Review & Comment
Institutional & Financial	MDC	OSP	MDC	Review & Comment
Evaluation	Corps	MDC MAPC EPA WPC DPH OSP CAG	Corps	Participate
RECOMMENDED PLAN				
Plan for the Area	MDC	All	MDC	Participate in Selection
Additional Treatment for Deer & Nut Island Flows	MDC	WPC EPA	MDC	Participate in Selection
Treatment & Disposal of Deer & Nut Island Sludges	MDC	WPC EPA	MDC	Participate in Selection
Implementation Plan	MDC	WPC EPA	MDC	
STUDY REPORT				
Summary & Main	MDC	Corps	MDC	Review & Comment
Technical Data Volumes				Review & Comment
Preparation	MDC Corps		MDC Corps	
Reproduction	Corps		Corps	

LEGEND:
Corps - U.S. Army Engineer Division, New England
MDC - Metropolitan District Commission
MAPC - Metropolitan Area Planning Council
EPA - Environmental Protection Agency
WPC - Massachusetts Division of Water Pollution Control
DPH - Massachusetts Department of Public Health
OSP - Massachusetts Office of State Planning
CAG - Citizens' Advisory Group

D. Background Information

1. The Study Area

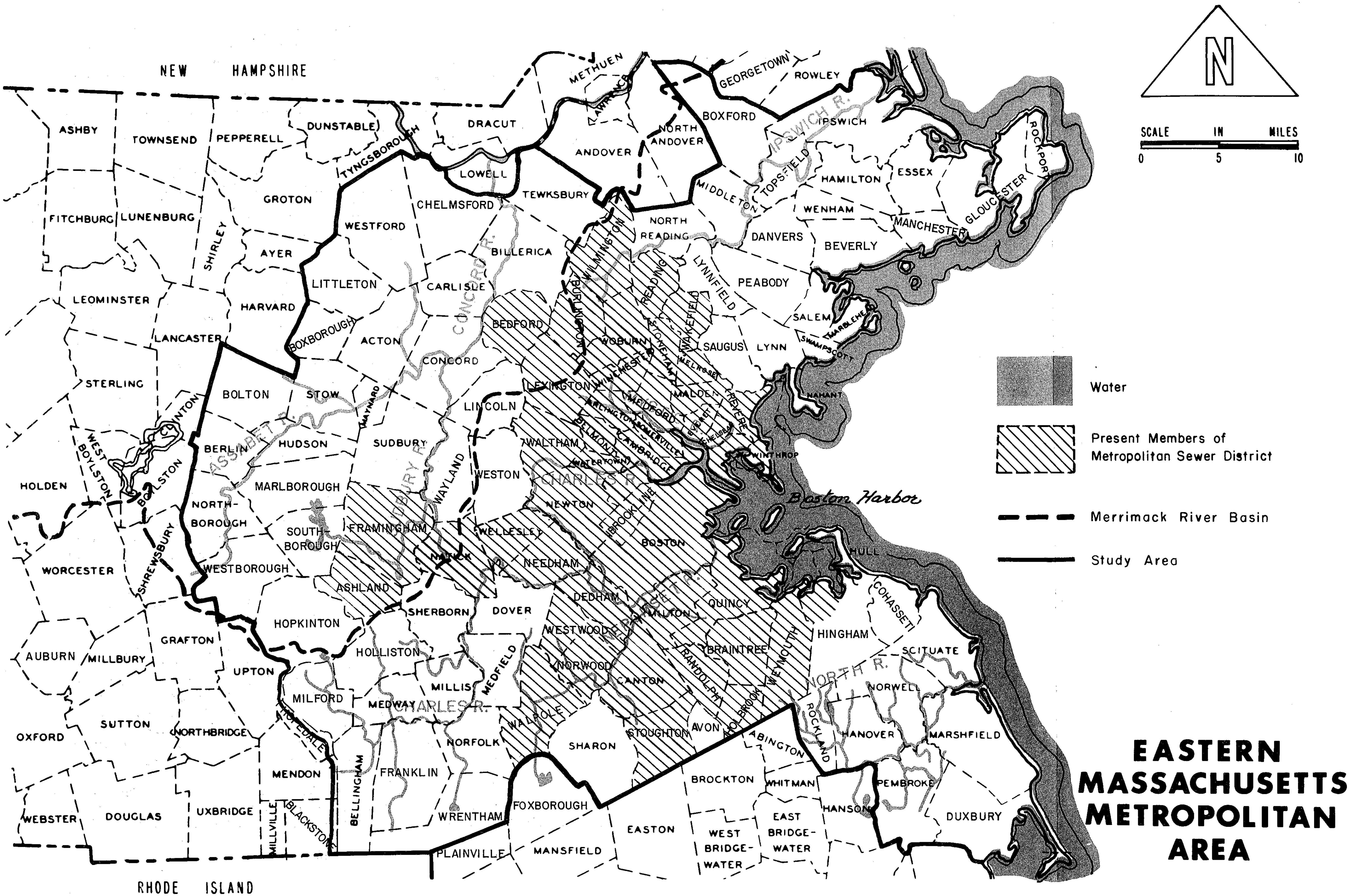
The Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study encompasses 109 cities and towns within a 30-mile radius of the City of Boston (Figure 8). Of the 109 cities and towns in the study area, 99 are members of the Metropolitan Area Planning Council. One community (Boxford) lies within the jurisdiction of the Merrimack Valley Planning Commission, four are within the jurisdiction of the Northern Middlesex Area Commission (Chelmsford, Billerica, Tewksbury, Westford), and three are within the Central Massachusetts Regional Planning Commission jurisdiction (Berlin, Northborough and Westborough). In 1970, some 3,129,200 people resided within this area of 1,760 square miles. It is projected that this population will increase to 3,800,000, 4,200,000 and 4,600,000 by the years 2000, 2020, and 2050, respectively. Population development is virtually complete in the core City of Boston with saturation radiating outward into the surrounding cities and towns. Population is expected to grow 92 percent in the outer suburbs by the year 2000, while it is projected to shrink 8 percent in the core area during the same time period.

2. Hydrology and Water Quality

The major waterways of the BH-EMMA study area consists of:

a. Boston Harbor
b. The Charles River
c. The Neponset River
d. The Mystic River
e. The SUASCO River System (Sudbury, Assabet and Concord Rivers)
f. The Ipswich River and North Coastal Waters
g. The North River and South Coastal Waters

Boston Harbor is a large (47 square miles) relatively shallow complex of bays and tidal estuaries, with 180 miles of tidal shoreline; it has three tributary streams of substantial length: The Mystic River to the north (length, 17 miles, including its major tributary, the Aberjona), the Charles River to the West (length, 80 miles) and the Neponset River to the south (length, 30 miles). The SUASCO River system, tributary to the Merrimack River, lies west of the Boston Metropolitan area. Both the Sudbury (length, 31 miles) and Assabet Rivers (length, 32 miles) originate in Westborough, Massachusetts and eventually flow northward to merge at Concord, Massachusetts to form the Concord River (length, 15 miles).



EASTERN MASSACHUSETTS METROPOLITAN AREA

FIGURE 8

The North Coastal area extends from the northern boundary of Boston Harbor to the mouth of the Ipswich River in Ipswich, Massachusetts. This area contains several harbors and the estuarine systems of the Ipswich, Pines and Saugus Rivers. The largest river tributary to the North Coastal area is the Ipswich River (length, 35 miles). The South Coastal area extends from Hull at the southern edge of Boston Harbor, southward to Duxbury. The North River system is the main tributary to this coastal area.

A breakdown of river basin drainage and stream flow of major rivers in the study area is shown in Table 6. Data on average, maximum and minimum discharges was obtained from flow records maintained by the U.S. Geological Survey (USGS). Low flow values were obtained from low flow frequency duration curves developed by the U.S. Army Corps of Engineers from USGS data.

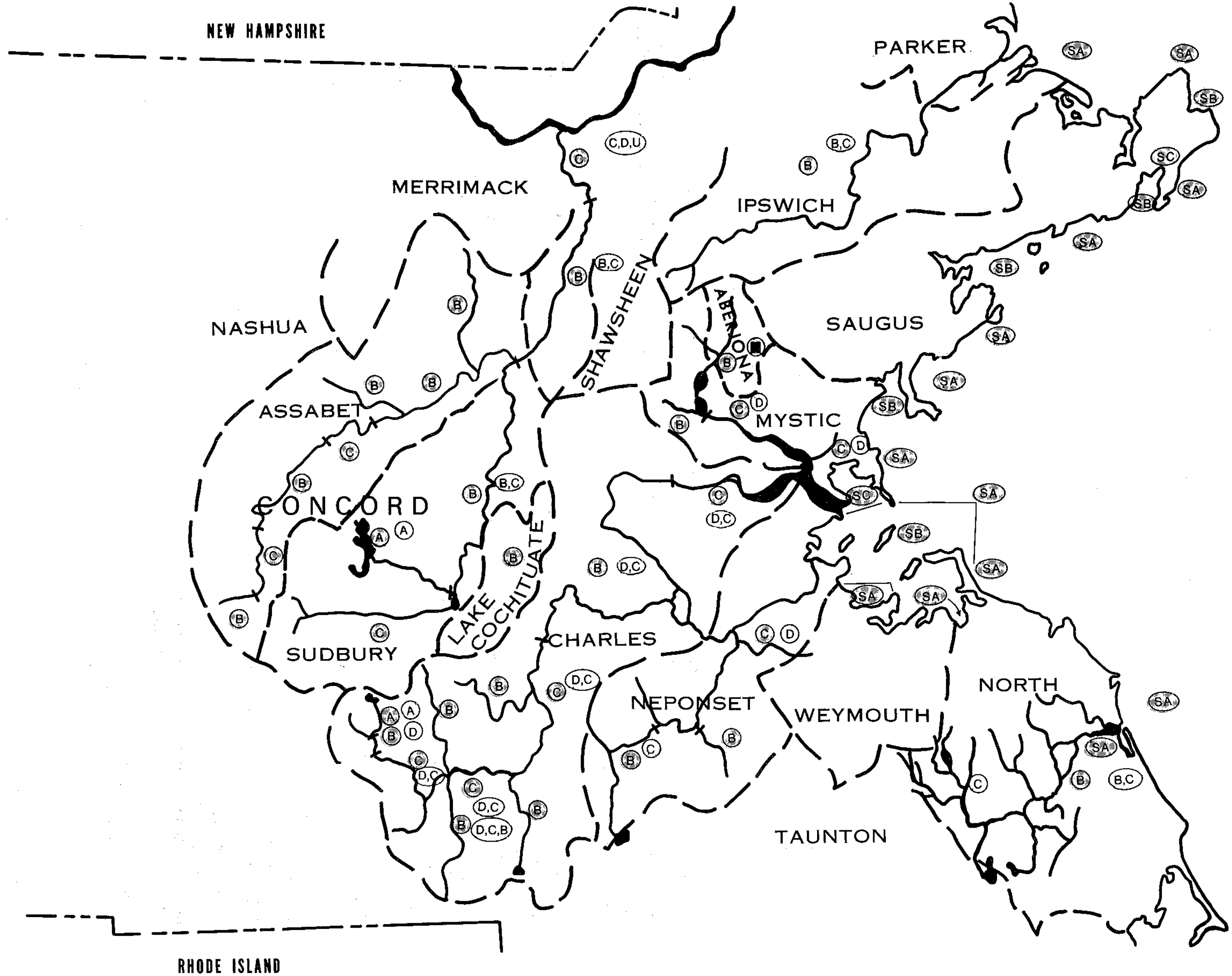
The quality of water in many of the various rivers, estuaries and coastal regions of the BH-EMMA study area currently does not meet water quality standards proposed by the Massachusetts Division of Water Pollution Control. Water quality standards are designated for all major waterways in Massachusetts in accordance with Section 303e of Public Law 92-500, and are based on the water's specific use. A description of Massachusetts Water Quality Standards criteria is presented in Tables 7 and 8. Classifications proposed for various segments of the major waterways in eastern Massachusetts are displayed in shaded letters in Figure 9. Present water quality is designated by circled letters next to the proposed classifications. Present classifications of D and U signify water quality inferior to Class Cl.

3. Industrial Waste Flows

Extensive efforts were made to determine the quantity and quality of wastewater to be treated in the Eastern Massachusetts Metropolitan Area. An important part of this effort was an inventory of industrial wastes.

The Corps of Engineers carried out the inventory of industrial wastes in two phases. The first phase sought to identify and locate the industries representative of the twenty-seven industrial groups delineated in PL 92-500. This effort identified 743 industries. Data was collected on the source and amount of industrial water used and the location and quantity of industrial process water discharge. Data on the characteristics of industrial waste streams was collected where available and estimated where unknown. The 743 industries were found to discharge 31 million gallons per day of industrial process wastewater. Ninety-two percent of this 31 million gallon per day came from industries discharging 50,000 gallons per day or more.

At the completion of this task, it was felt that an additional effort should be made to inventory the discharges of the larger manufacturing industries in the study area to determine all dischargers



WASTEWATER MANAGEMENT
NEWS
MERRIMACK RIVER BASIN
BOSTON METROPOLITAN AREA

EXISTING CONDITIONS AND STREAM CLASSIFICATIONS

FIG. 9

River Characteristics

River (location) Years of Record	Drainage Area (sq. mi.)	Average Discharge (cfs)	Maximum Discharge (cfs)	Minimum Discharge (cfs)	7 day - 10 year Low Flow (cfs)
Mystic River (Aberjona River at Winchester) 1930-1971	69	26.7	835	< 1	.39
Neponset River (at Norwood Mass.) 1939-1971	121	51.6	1490	1.4	4.7
Charles River (at Charles River Village, Mass.) 1937-1971	307	294	3220	.5	10.5
Assabet River (at Maynard, Mass.) 1941-1971	175	176	4250	-	3.4
Sudbury River (at Framingham Center, Mass) 1875-1971	169	112	-	-	-
Concord River (below River Meadow Brook at Lowell, MA) 1936-1971	405 Total 312 Net	446	1970	-	28
Ipswich River (near Ipwisch, Mass) 1930-1971	155	198	2680	.8	2.0
North River (Indian Head River at Norwell) 1952-1971	123	59.5	1390	.18	-

TABLE 7

COMMONWEALTH OF MASSACHUSETTS
WATER QUALITY STANDARDS

Fresh Water Standards

Item	Class A Use: Public Water Supply	Class B Uses: Contact recreation Water Supply with treatment and disinfection Fishing Industrial and Agricultural	Class B-1 Use: Same as B	Class C Uses: Non-contact recreation Fishing Water supply with treatment and disinfection under special conditions	Class C-1 Uses: Same as C
1. Dissolved oxygen	Not less than 75% of saturation during at least 16 hours of any 24 hour period and not less than 5 mg/l at any time. For cold water streams the dissolved oxygen concentration shall not be less than 6 mg/l during the season.	Not less than 75% of saturation during at least 16 hours of any 24 hour period and not less than 5 mg/l at any time. For cold water streams the dissolved oxygen concentration shall not be less than 6 mg/l during the season.	Not less than 5 mg/l during at least 16 hours of any 24 hour period, nor less than 3 mg/l at any time. For seasonal cold water fisheries at least 6 mg/l must be maintained during the season.	Not less than 5 mg/l during at least 16 hours of any 24 hour period, nor less than 3 mg/l at any time. For seasonal cold water fisheries at least 6 mg/l must be maintained during the season.	Not less than 2 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oil-grease-scum	None allowable.	None other than of natural origin or those amounts which may result from the discharge from waste treatment facilities providing appropriate treatment. For oil and grease of petroleum origin the maximum allowable concentration is 15 mg/l.	Same as Class B	None other than of natural origin or those amounts which may result from the discharge from waste treatment facilities providing appropriate treatment. For oil and grease of petroleum origin the maximum allowable concentration is 15 mg/l.	Same as Class C
3. Color and turbidity	None other than of natural origin.	None in such concentration that would impair any uses specifically assigned to this class.	Same as Class B	None allowable in such concentrations that would impair any uses specifically assigned to this class.	Same as Class C
4. Total Coliform bacteria per 100 ml.	Not to exceed an average value of 50 during any monthly sampling period.	Not to exceed an average value of 1000 nor more than 1000 in 20% of the samples.	Same as Class B	None in such concentrations that would impair any usages specifically assigned to this class, see Note 1*.	Same as Class C
5. Taste and odor	None other than of natural origin.	None in such concentrations that would impair any uses specifically assigned to this class and none that would cause taste and odor in edible fish.	Same as Class B	None in such concentrations that would impair any uses specifically assigned to this class, and none that would cause taste and odor to edible fish.	Same as Class C
6. pH	As naturally occurs.	6.5 - 8.0	Same as Class B	6.0 - 8.5	Same as Class C
7. Allowable temperature increase	None other than of natural origin.	None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83° F in warm water fisheries, or in any case raise the normal temperature of the receiving water more than 4°F	Same as Class B	None except where the increase will not exceed the recommended limits on the most sensitive receiving water use and in not case exceed 83°F in warm water fisheries, and 68°F in cold water fisheries, or in any case raise the normal temperature of the receiving water more than 4°F.	Same as Class C
8. Chemical constituents	None in concentration or combinations which would be harmful or offensive to humans, or harmful to animal or aquatic life.	None in concentrations or combinations which would be harmful or offensive to human, or harmful to animal or aquatic life or any water use specifically assigned to this class.	Same as Class B	None in concentrations or combinations which would be harmful or offensive to human life, or harmful to animal or aquatic life or any other water use specifically assigned to this class.	Same as Class C
9. Radioactivity	None in concentrations or combinations in excess of the limits specified by the United States Public Health Service Drinking Water Standards.	None other than that occurring from natural phenomena.	Same as Class B.	None in such concentrations or combinations in excess of the limits specified by the United States Public Health Service Drinking Water Standards.	Same as Class C

*Note 1 - no bacteria limit has been placed on Class "C" waters because of the urban runoff and combined sewer problems which have not yet been solved. In waters of this class not subject to urban runoff or combined sewer discharges the bacterial quality of the water should be less than an average of 5,000 coliform bacteria/100 ml during any monthly sampling period. It is the objective of the Division of Water Pollution Control to eliminate all point and non-point sources of pollution and to impose bacterial limits on all waters.

TABLE 8

COMMONWEALTH OF MASSACHUSETTS
WATER QUALITY STANDARDS

Salt Water Standards

Item	Class SA Uses: Contact Recreation Fishing Open Shellfish Harvesting	Class SB Uses: Contact Recreation Fishing Shellfish Harvesting with depuration	Class SC Uses: Non-contact Recreation Fishing Closed to Shellfish Harvesting
1. Dissolved oxygen	Not less than 6.5 mg/l at any time.	Not less than 5.0 mg/l at any time.	Not less than 5 mg/l during at least 16 hours of any 24 hour period nor less than 3 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oil grease-scum	None other than of natural origin or those amounts which may result from the discharge from waste treatment facilities providing appropriate treatment. For oil and grease of petroleum origin the maximum allowable concentration is 15 mg/l.	None other than of natural origin or those amounts which may result from the discharge from waste treatment facilities providing adequate treatment. For oil and grease of petroleum origin the maximum allowable concentration is 15 mg/l.	None other than of natural origin or those amounts which may result from the discharge from waste treatment facilities providing appropriate treatment. For oil and grease of petroleum origin the maximum allowable concentration is 15 mg/l.
3. Color and trubidity	None in such concentrations that will impair any uses specifically assigned to this class.	None in such concentrations that would impair any uses specifically assigned to this class.	None in such concentrations that would impair any uses specifically assigned to this class.
4. Total Coliform bacteria per 100 ml	Not to exceed a mediam value of 70 and not more than 10% of the samples shall ordinarily exceed 230 during any monthly sampling period.	Not to exceed an average value of 700 and not more than 1000 in more than 20% of the samples.	None in such concentrations that would impair any uses specifically assigned to this class. See Note 2.*
5. Taste and odor	None allowable.	None in such concentrations that would impair any uses specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.	None in such concentrations that would impair any uses specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.
6. pH	6.8 - 8.5	6.8 - 8.5	6.5 - 8.5
7. Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive water use.	None except where the increase will not exceed the recommended limits on the most sensitive water use.	None except where the increase will not exceed the recommended limits on the most sensitive water use.
8. Chemical constituents	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other use.	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the waters for any other uses.	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other use.
9. Radioactivity	None in such concentrations or combinations in excess of the limits specified by the United States Public Health Service Drinking Water Standards.	None in concentrations or combinations in excess of the limits specified by the United States Public Health Service Drinking Water Standards	None in such concentrations or combinations in excess of the limits specified by the United States Public Health Service Drinking Water Standards.

*Note 2 - no bacteria limit has been placed on Class "SC" waters because of the urban runoff and combined sewer problems which have not yet been solved. In waters of this class not subject to urban runoff combined sewer discharges the bacterial quality of the water should be less than an average of 5,000 coliform bacteria/100 ml during any monthly sampling period. It is the objective of the Division to eliminate all point and non-point sources of pollution and to impose bacterial limits on all waters.

of 50,000 gallons per day or more. All industrial categories were examined, however, the number of industries examined was limited by the firm's characteristic water use and employment. For those industrial types with an inherent low water use, only the firms employing more than 250 people were examined. For high water using industries, those employing more than 100 people were examined. All industries determined in the previous effort to discharge over 50,000 gallons of wastewater per day were examined. An additional 180 industries were examined in this effort. Only 24 of the additional 180 industries were found to discharge 50,000 gallons per day or more of industrial wastes. Table 9 summarizes the results of the two efforts.

Subsequent to the efforts described above, a cooperative effort with the Commonwealth of Massachusetts was undertaken to visit 118 known or suspected large dischargers to determine the sources and characteristics of their process wastewater. Attempts were also made to determine each industry's future plans with respect to quality and treatment of wastewater discharge. Finally, a sampling program was conducted aimed at indexing key industries which were major dischargers of "compatible" wastes. "Compatible" discharges are discharges with substantial BOD and suspended solids loadings, which are for the most part adequately treated by municipal wastewater treatment facilities. A tanner, a gelatin manufacturer, two paper mills, one textile mill, one ice cream producer, a fish processor, and a meat processor were sampled. All data gathered in this effort was obtained on the basis that it would be kept confidential for planning use only. Therefore, no statistics are reported here.

In general, the industries in Eastern Massachusetts were willing to cooperate in the study's effort to upgrade the level of wastewater treatment.

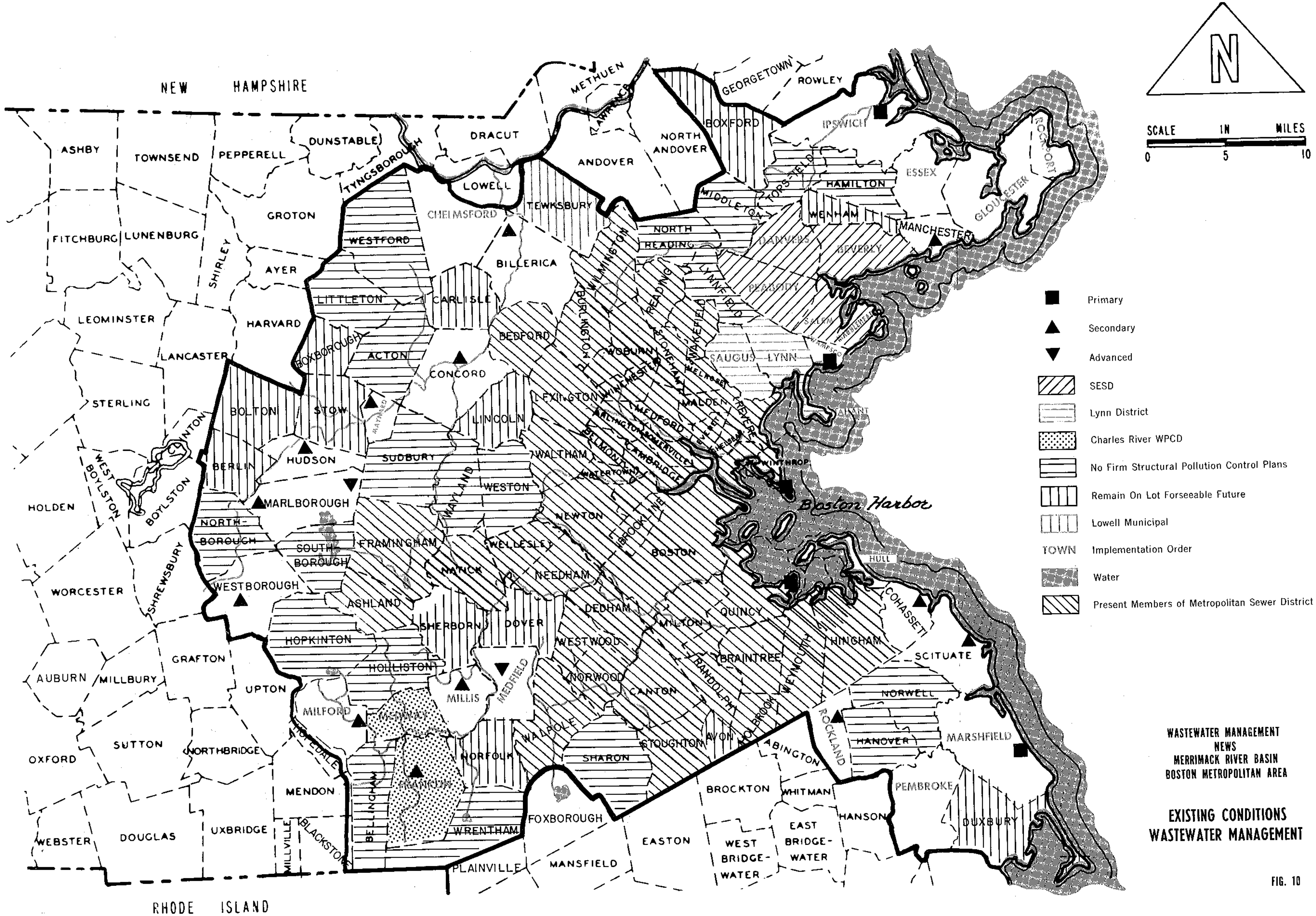
4. Existing Wastewater Management

Current wastewater management practices vary throughout the area. In the center of the Boston Harbor-Eastern Massachusetts Metropolitan Area, 43 communities are wholly or partially served by the Metropolitan Sewerage District (MSD) as part of the MDC (see Figure 10). Each municipality within the MSD is responsible for maintenance and operation of its own sewerage system prior to discharging into the MSD trunk sewers. Each community is also subject to the rules and regulations set forth by the Metropolitan District Commission. The MSD system consists of more than 200 miles of trunk sewers, covering an area of approximately 400 square miles and serving approximately 2 million people. Except for wastewater discharged through combined sewer overflows and/or discharged to surface waters, wastewater in the MSD system receives primary treatment and chlorination at either Deer Island or Nut Island treatment facilities before it is discharged into Boston Harbor. These facilities have an average daily treatment capacity of more than 450 million gallons per day, with a combined capability of handling maximum

TABLE 9

INDUSTRIAL WASTE INVENTORY

Industrial Group	No. of Firms Examined	Discharge Identified gallons/day	No. of Firms Discharging 50,000 gallons/day	Total Large Discharge gallons/day
Food (SIC 20)	169	8,977,500	29	7,836,500
Textile (SIC 22)	106	2,340,000	9	2,097,000
Paper (SIC 26)	29	5,174,000	4	5,172,500
Chemical & Allied Industries (SIC 28, 29 & 30)	114	8,281,300	13	8,247,000
Metals & Metal Products (SIC 33, 34, 35 & 37)	120	1,911,600	7	1,829,000
Others	387	9,993,998	33	8,725,690
TOTAL EXAMINED	925	36,678,398	95	33,907,690



WASTEWATER MANAGEMENT NEWS
MERRIMACK RIVER BASIN
BOSTON METROPOLITAN AREA

EXISTING CONDITIONS WASTEWATER MANAGEMENT

FIG. 10

flows at the rate of 1.2 billion gallons per day. Currently, the facilities need extensive improvements, as wastewater flows exceed the capacity of many parts of the system, and receive inadequate treatment, thereby threatening the Harbor's recreational uses.

To the north of the MSD, the communities of Beverly, Danvers, Peabody, Salem and Marblehead have combined to form the South Essex Sewerage District (SESD). A primary treatment facility to handle the wastewater flow of this District is under construction in Salem and planning is underway for secondary treatment. Manchester has a secondary treatment plant, and Swampscott and Ipswich have primary facilities.

In the SUASCO Basin secondary facilities exist at Billerica, Concord, Maynard, Hudson, Marlborough (West), and Westborough. Marlborough also has an advanced waste treatment plant serving the Eastern portion of the community.

In the Charles River Basin, Milford, Franklin and Millis have secondary treatment facilities and Medfield has a new advanced treatment facility.

On the South Shore, Cohasset, Scituate and Rockland have secondary facilities and Marshfield has a small primary treatment plant.

Many of these treatment facilities in areas outside the MSD are also in need of expansion and improved treatment to assure compliance of waters receiving their discharge with water quality standards set up by the Commonwealth of Massachusetts (see Section B.2).

The overall existing wastewater management system is illustrated in Figure 10.

5. Water Supply

The Metropolitan District Commission's water supply system is the largest regional system within New England. At present, this system supplies either wholly or partially the water supply needs of 42 communities within the Commonwealth of Massachusetts. Consumers of the serviced population number about two million or fully 37 percent of the Commonwealth's 1970 population.

Existing dependable yield of the system is estimated to be 300 mgd. Average daily water consumption furnished by the system in 1971 was 322 million gallons per day (thus the system is outstripping available supply) of which 273 mgd was delivered to municipalities which rely exclusively upon the MDC as their only supply source.

The MDC relies upon surface water as its supply source. Three major reservoirs: Quabbin, Wachusett and Sudbury impound flow from tributaries of both the Connecticut and Merrimack River Basins.

The short-term future needs can be met by the recommended Millers River and Northfield Mountain projects. In the long range, the Connecticut or Merrimack Rivers, or a regional groundwater system, have been identified.

The Metropolitan Area Planning Council made a study in 1969 of the water supply needs of the Boston Metropolitan area. The following summarizes their findings for those communities not presently served by the MDC.

a. Ipswich River Subdistrict: Two of the communities listed below have adequate existing supplies to meet their projected 1990 demands. An additional six communities have potential supplies which could adequately supplement their existing supplies through 1990. However, the potential supplies in five of the communities and the existing supplies in one of the communities make use of the Ipswich River.

Beverly	Ipswich	Reading
Boxford*	Lynn	Rockport
Danvers	Lynnfield	Rowley*
Essex	Manchester	Salem
Georgetown*	Middleton	Topsfield
Gloucester	North Reading	Wenham
Hamilton	Peabody	Wilmington

*Not in Council District

The Ipswich River does not have the capacity to meet these collective demands. Unless the Ipswich River is supplemented, it will be unable to supply sufficient additional yield to even the communities which now pump from it. Through the construction of three new off-stream reservoirs, together with a diversion system from the Merrimack River, the Ipswich River can be developed to adequately supplement the existing and potential supplies of the communities in the Ipswich River Subdistrict. The Merrimack River is the only possible source which would permit diversion to the Ipswich during dry periods, thus reducing the size of the off-stream reservoirs required. The longer the period of diversion, the smaller the size of the reservoirs required to produce the same yield.

b. Concord River Subdistrict: None of the MAPC communities in this subdistrict will be able to adequately meet their projected 1990 demands. However, the communities in the Concord River Subdistrict can also be supplied by the Merrimack River. This subdistrict includes four MAPC communities: Acton, Bedford, Concord and Littleton, and 13 communities adjacent to the Council District.

c. Charles River Subdistrict: The third subdistrict considered includes the 17 communities in or adjacent to the Charles River watershed and listed below:

Bellingham	Milford	Walpole
Dover	Millis	Wayland
Franklin	Natick	Wellesley
Holliston	Norfolk	Westwood
Medfield	Sherborn	Wrentham
Medway	Sudbury	

Five of these communities can develop potential supplies to adequately meet their projected 1990 demands. The communities in this subdistrict have been subdivided into two groups, the Upper and the Middle Charles River Groups. By developing the abundant potential local supplies of Franklin and Milford and interconnecting the individual system, the six communities in the Upper Charles River Group can adequately meet their projected 1990 demands. The 11 communities in the Middle Charles River Group can extend the adequacy of their systems by growing together similar to the Upper Charles River Group.

However, unless the MDC is extended to supply Sudbury, Medfield, Norfolk and Dedham, the combined 1990 demands cannot be met even if all potential supplies are developed. Following the completion of the MAPC study, the NEWS study requested the opinion of the U.S. Geological Survey (USGS) concerning the hydraulic relationship of the well field proposed for the Middle Charles River Group and the river. The USGS replied they felt the proposed well field in essence would be drawing from river flow, particularly in low flow periods. Low flow conditions in the Charles River at present are a critical factor in the river's water quality. It was felt that any substantial decrease in flow caused by withdrawals for water supply would increase water quality problems. Thus, the NEWS study proposed communities listed as middle Charles to be served by connection to the regional system.

Land use controls are extremely important for the protection of small local surface and groundwater supplies from pollution. The NEWS water supply studies recognize the need for small local sources for incremental quantities of water to meet overall demand in conjunction with the large amounts of water to be supplied by proposed regional systems.

d. Neponset River Subdistrict: Only the Town of Sharon in this subdistrict, consisting of Avon, Foxborough, Sharon and Stoughton, can develop supply adequate through 1990. The remaining three subdistrict communities will require an outside supplementing source of supply. The projected 1990 demand of the Neponset River Subdistrict can be adequately met through the development of Ponkapoag Pond as a water supply reservoir. By raising the level of the pond some 19 feet, adequate storage capacity can be provided to receive flood flows pumped from the Neponset River. Water would be pumped from the Neponset River only during periods when the flow exceeds 25 cubic feet per second (cfs).

During dry periods, pumping will be permitted only over a few months of the year. In order to provide sufficient yield, it will be necessary to provide pumping capacity greatly in excess of the estimated safe yield of the system.

e. North River Subdistrict: The fifth subdistrict system investigated would provide supplemental supply to communities located south and southeast of Boston. This North River Subdistrict includes the 15 communities located in the MAPC District, listed below, plus the communities in the Old Colony Planning Council.

Braintree	Holbrook	Randolph
Cohasset	Hull	Rockland
Duxbury	Marshfield	Scituate
Hanover	Norwell	Stoughton
Hingham	Pembroke	Weymouth

Cohasset is the only member community which can develop supplies adequate through 1990. However, providing all of the communities develop their potential supplies, the North River could be developed to supply all of the communities in the subdistrict well beyond the year 1990 with the exception of the Towns of Braintree, Weymouth, Randolph and Holbrook. While these communities could be supplied by the North River, it would be more realistic to supplement the supplies of these communities from the MDC, since they are remote from the North River, near the existing MDC system, and their demands would decrease the North River's period of adequacy. The only source that will be available to supplement the North River once the demands exceed its yield is the MDC, and these four communities would have to be connected to the MDC eventually.

6. Projections

a. Population, Employment and Land Use

Any wastewater management study requires the development of certain background data to provide the basis for the development of alternatives. Therefore, the first major task of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study was to estimate the number of people that would be living in the study area in the future and where within the area they would live and work.

The first step was to prepare estimates of population for the study area. The procedure used consisted of three steps:

(1) Preparation of projections using the regional share method and the cohort-component method.

(2) Comparison of the results with each other and with other projections for the study area.

(3) Election of high and low estimates of population for the study area.

Figure 11 displays the Boston Harbor-EMMA projections against other population projections prepared for the region.

It is noted that MDC's consultant did not use the OBERS projections. Table 10 displays the Boston Harbor-EMMA Wastewater Management Study projections against the Boston SMSA Series C and Series E OBERS projections. Also OBERS projections are shown for the Eastern Massachusetts Metropolitan Area (EMMA). These were computed by the average ratio of the EMMA population to the SMSA population for 1960 and 1970 time periods. These figures are presented for comparison purposes only. It should be noted that the EMMA projections are lower than the OBERS Series E projections. The EMMA projections were made using a birth rate slightly below the replacement level. This appears to be appropriate for the EMMA area. A complete discussion of the methodology may be found in Technical Data Volume 1 of the Wastewater Engineering and Management Plan for Boston Harbor-EMMA.

The next task was to estimate the employment throughout the study area. Employment was projected in five categories: (1) dry manufacturing, (2) wet manufacturing, (3) very wet manufacturing, (4) non-manufacturing industry, and (5) commercial. The projections indicated a decrease in employment in the manufacturing part of the economy and an increase in the service sector.

The next task was to allocate the population and employment to the 109 communities within the study area. In order to accomplish this task systematically, with as little bias as possible, the EMPIRIC Activity Allocation Model was utilized. This model utilized current data on population, employment, land use, water and sewer use and transportation to develop small area projections of population, employment and land use in the study area for the years 2000, 2020 and 2050. The methodology and results of this effort are described in Technical Data Volume 1 of the Wastewater Engineering and Management Plan for Boston Harbor-EMMA. Table 11 shows the distribution of population and employment between the current 43 members of the Metropolitan Sewerage District and the entire Boston Harbor-EMMA.

b. Wastewater Flows

The data gathered in the industrial survey formed the basis of the industrial component of the wastewater flows. The total quantity of wastewater flow was computed for each community using the following criteria:

(1) Water Consumption: 1970 consumption with a per capita increase of 1 gallon per capita per day per year until 2020; thereafter no increase.

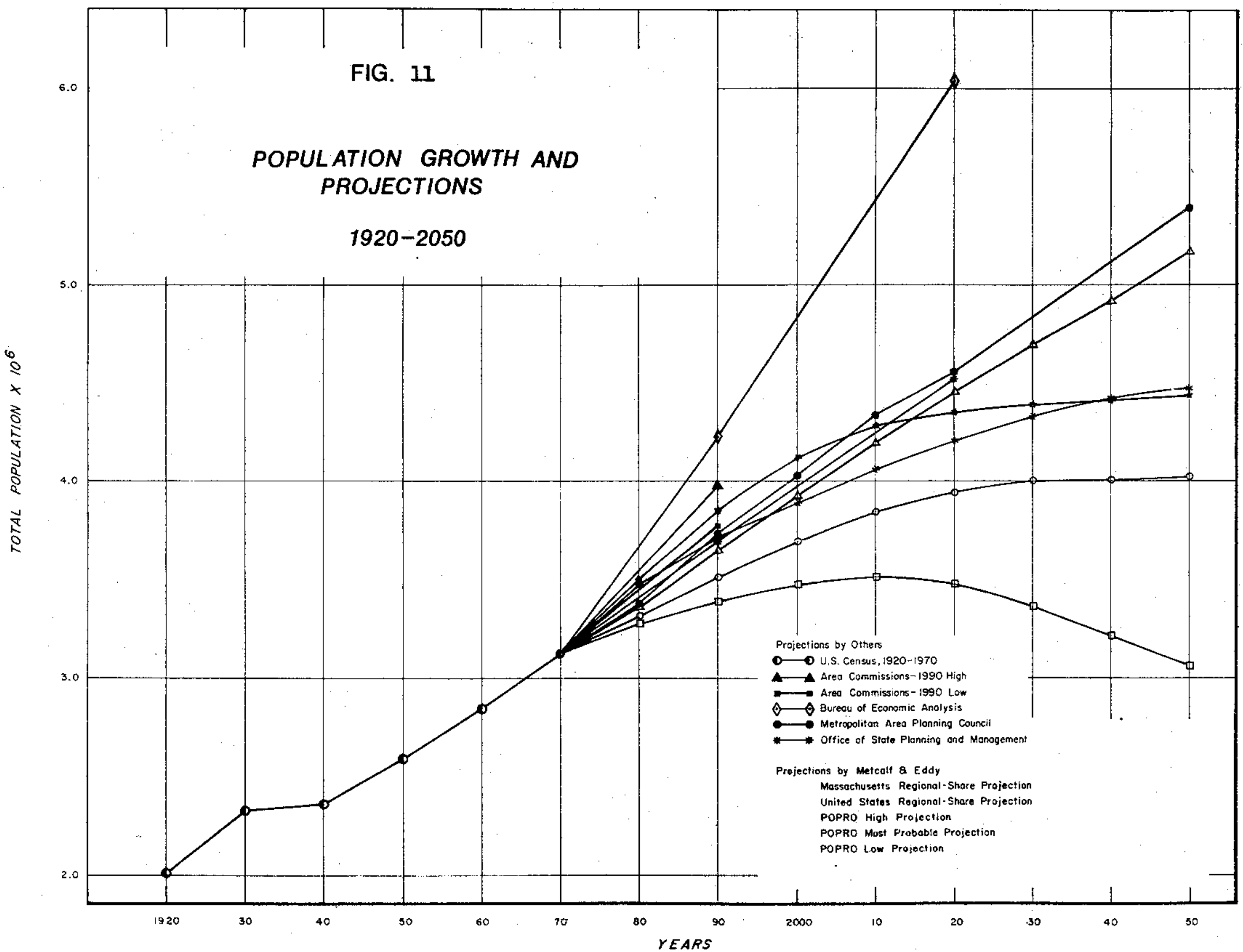


FIG. 11

POPULATION GROWTH AND PROJECTIONS

1920–2050

TABLE 10

BOSTON HARBOR-EASTERN MASSACHUSETTS METROPOLITAN AREA WASTEWATER MANAGEMENT STUDY PROJECTIONS VERSUS OBERS

	1960	1970	1990	2000	2020	2050
EMMA	2,847,900	3,129,200	3,566,300	3,806,600	4,196,200	4,565,800
Boston SMSA OBERS Series E	3,337,013	3,715,118	4,567,600	4,995,000	5,819,100	
Boston SMSH OBERS Series C	"	"	5,125,300	5,872,800	7,648,600	
EMMA OBERS Series E	"	"	3,873,325	4,236,184	4,934,597	
Series C	"	"	4,346,254	4,980,134	6,486,012	

TABLE 11

DISTRIBUTION OF POPULATION AND EMPLOYMENT
CURRENT MSD VERSUS BH-EMMA STUDY AREA

POPULATION

	1970	2000	2020	2050
Metropolitan Sewerage District (MSD)	2,219,200	2,423,200	2,527,900	2,509,200
Boston Harbor-Eastern Massachusetts Metropolitan Area (BH-EMMA)	3,129,200	3,806,600	4,196,200	4,565,800

EMPLOYMENT

	1970		2000		2020		2050	
	Manufacturing	Other	Manufacturing	Other	Manufacturing	Other	Manufacturing	Other
MSD	223,800	932,300	147,400	1,057,500	129,700	1,077,800	97,700	1,152,500
BH-EMMA	302,000	1,086,800	237,400	1,420,700	217,700	1,615,400	182,400	2,055,700

(2) Residential and Commercial Wastewater: 80% of water consumed is returned to the sewers.

(3) Industrial Wastewater:

Dry Manufacturing	170 gallons per employee per day
Wet Manufacturing	700 gallons per employee per day
Very Wet Manufacturing	2000 gallons per employee per day

(4) Infiltration:

New sewers (built after 1959)	30 gallons per capita per day
Middle-aged sewers (built between 1940 and 1959)	60 gallons per capita per day
Old sewers (built before 1940)	90 gallons per capita per day

A summary of the projected wastewater flows for 2000 and 2020 is presented in Table 12.

E. Treatment Technology

The study's division of tasks required the MDC to design water-oriented municipal waste treatment systems and solutions for combined sewer overflows. The U.S. Army Corps of Engineers was required to develop a land-oriented waste treatment system and solutions for stormwater runoff.

1. Water-Oriented Treatment

A variety of treatment processes was examined by consultants to the MDC in the development of treatment systems for the Boston Harbor-Eastern Massachusetts Metropolitan Area. The selected processes depended largely on criteria that had to be met to comply with Massachusetts water quality standards and the requirements of PL 92-500.

The majority of wastewaters discharged today in the Boston Harbor-Eastern Massachusetts Metropolitan Area receive primary treatment with disinfection. The objective of primary treatment is to remove settleable solids, suspended solids (SS) and associated oxygen demanding substances (BOD). Disinfection is utilized to remove potential disease-producing organisms. The current concentrations of BOD, suspended solids and coliform bacteria in the Deer and Nut Island treatment facilities effluent, and percent removal of these substances achieved at the two facilities is given in Table 13.

For proposed discharges to ocean estuarine waters, the MDC's consultants recommended secondary treatment with disinfection. Secondary treatment removes, through biological action, greater percentages of suspended solids and oxygen demanding wastes. This recommendation is in accordance with the requirement for universal secondary

TABLE 12

WASTEWATER FLOWS
(MGD)

	2000				2020			
	Residential & Commercial	Industrial	Infiltration	Total	Residential & Commercial	Industrial	Infiltration	Total
Metropolitan Sewerage District	264.62	75.64	190.15	530.41	324.55	70.02	193.97	588.54
Boston Harbor-EMMA	352.71	105.50	238.50	696.66	482.06	101.27	258.00	841.33

TABLE 13

AVERAGE CHARACTERISTICS OF DEER AND NUT ISLANDS
TREATMENT FACILITIES EFFLUENT
(Data taken from 54th Annual Report of the
MDC Sewerage Division, Year ending June 30, 1974)

Substance	Deer Island: Effluent Concentration (ppm)	Deer Island: % Removal	Nut Island: Effluent Concentration (ppm)	Nut Island: % Removal
BOD	88	33%	88	29%
SS	56	56%	114	46%
Coliform bacteria	762	99.999%	1,600	99.92%

DEER ISLAND SEWERAGE TREATMENT PLANT

treatment as set forth in PL 92-500. Secondary treatment may also meet the requirement of best practicable waste treatment before discharge to the ocean environment.

For discharges to freshwater streams in the Eastern Massachusetts Metropolitan Area, the Massachusetts Division of Water Pollution Control determined that additional treatment beyond secondary treatment is necessary to meet 1983 requirements of PL 92-500. They indicated that, until further analysis proves different, required treatment for wastewater discharges to freshwater systems would consist of secondary treatment with phosphorus removal, complete nitrification with filtration and post aeration. This treatment chain would remove virtually all of the suspended solids and oxygen demanding substances and a large portion of the phosphorus. All ammonia would be converted to nitrate.

The flow diagrams corresponding to the above discussion are shown in Figure 12. The recommended treatment process was principally developed by the MDC engineering consultant.

No consideration was given to the removal of metals and industrial chemicals in the design of treatment processes as an important assumption was made early in the study that all industries would pretreat their wastes before discharge to municipal systems to insure that the waste would be compatible with the treatment works. This assumption could result in the oversizing of some facilities, but the work conducted under the industrial inventory showed that the majority of the industries had joined a municipal system where one was available.

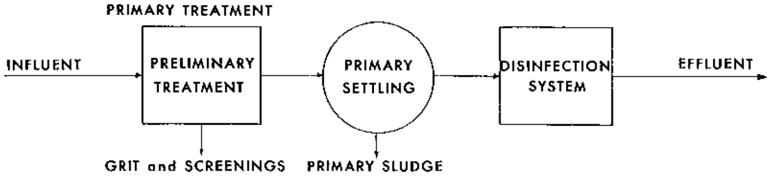
2. Land-Oriented Treatment

Applying domestic wastes to the land is a very old technique that has been tried and proved reliable throughout man's history. Only recently, however, has there been renewed interest in land treatment as an alternative to conventional wastewater treatment techniques. The land treatment alternative, developed by the Corps of Engineers, was considered as a process for effluent renovation consistent with the 1983 and 1985 water quality objectives of PL 92-500, as well as a process for nutrient recovery through crop production. Properly managed land treatment systems can be expected to use secondary treatment effluent as a resource by recycling nutrients to natural systems. Figure 13 displays the mechanics of a typical land treatment system.

There are three commonly used techniques for land treatment: spray irrigation, overland flow and rapid infiltration. The physical soil characteristics of a proposed treatment site essentially determine which technique is best suited for a particular area. Other more important considerations are land characteristics, depth to groundwater and the proximity of residential or commercial development.

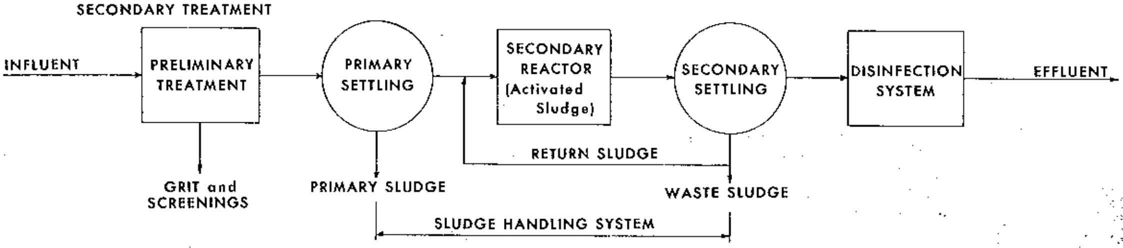
AVERAGE SEWAGE	MONTHLY AVERAGE
BOD_5	200mg/l
SS	200 mg/l
NH_3-N	25 mg/l
Total N	40 mg/l
Phosphorus as P	10 mg/l
Fecal Coliform Bacteria	6×10^7 /100ml
pH	6.0-9.0

PRIMARY TREATMENT



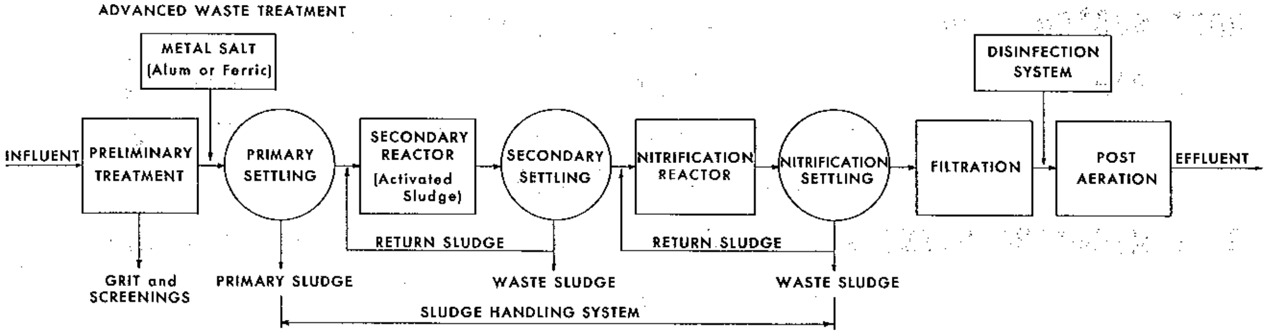
EXPECTED EFFLUENT QUALITY	MONTHLY AVERAGE
BOD_5	100 mg/l
SS	75 mg/l
NH_3-N	25 mg/l
Phosphorus as P	35 mg/l
Total N	38 mg/l
Fecal Coliform Bacteria	1×10^3 /100 ml
pH	6.0-9.0

SECONDARY TREATMENT



EXPECTED EFFLUENT QUALITY	MONTHLY AVERAGE
BOD_5	30 mg/l
SS	30 mg/l
NH_3-N	25 mg/l
Total N	30 mg/l
Phosphorus as P	5 mg/l
Fecal Coliform Bacteria	200/100 ml
pH	6.0-9.0

ADVANCED WASTE TREATMENT

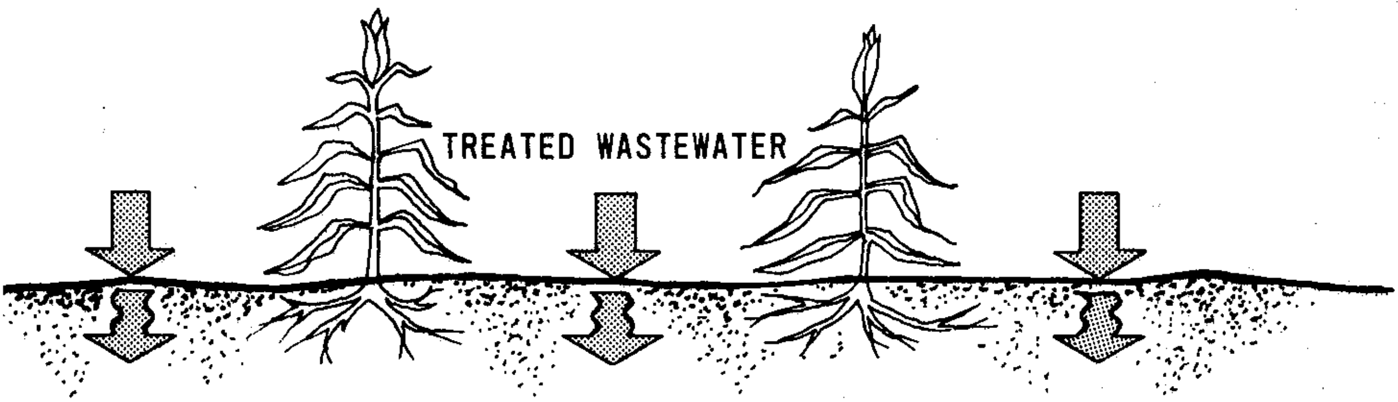


EXPECTED EFFLUENT QUALITY	MONTHLY AVERAGE
BOD_5	5 mg/l
SS	5 mg/l
NH_3-N	< 1 mg/l
Total N	30 mg/l
Phosphorus as P	< 1 mg/l
Fecal Coliform Bacteria	200/100 ml
pH	6.0-9.0

TREATMENT TRAINS AND EFFLUENT QUALITY

Figure 12

LAND TREATMENT PROCESS



ROOT SYSTEMS	-	TAKE UP SOLUBLE NUTRIENTS
SOIL PARTICLES	-	MECHANICALLY STRAIN SUSPENDED SOLIDS
	-	ADSORB BACTERIA, VIRUSES, PHOSPHORUS, AND HEAVY METALS
SOIL MICROORGANISMS	-	CONSUME DISSOLVED ORGANIC, NITROGENOUS AND PHOSPHORUS MATERIALS

FIGURE 13

Overland Flow - This technique was not considered in the development of this wastewater management alternative due to the absence of suitable sites in the study area.

Spray Irrigation - Land areas within the study area that were best suited for spray irrigation consisted of silty loam, loam and sandy loam soils. Crop uptake of nutrients, which are the same as those found in commercial fertilizer, plays a major role in the long-term effectiveness of these systems which maximize the use of water and nutrients input through crop production. As applied effluent seeps through the soil, micro-organisms degrade organic substances, plants utilize the nutrients, while other effluent constituents become fixed in the soil horizon.

Rapid Infiltration - The soils required for this process are very permeable deposits of sands and gravels to which large volumes of effluent can be applied. It is especially suited to areas where groundwater recharge and flow augmentation of nearby streams are needed. Crop uptake of nutrients coupled with periodic harvesting is not critical because nutrient removal is accomplished by efficient management of the system to allow nitrification-denitrification of the applied wastewater's total nitrogen content and soil chemical fixation of phosphorus. The technique of rapid infiltration contrasts to spray irrigation in that spray irrigation emphasizes treatment by recycling nutrients back through the food chain and enhances crop productivity while rapid infiltration is more of a flow augmentation groundwater recharge technique.

The Corps of Engineers assumed that secondary effluent of the quality proposed for ocean discharge in the water-oriented systems would be applied to the land. Figure 14 illustrates the treatment sequence used in the design of the land-oriented advanced waste treatment system. Table 14 indicates the pollutant removals that can be expected in the land systems. Again metals were not considered as it was assumed they would be eliminated through industrial pretreatment requirements.

3. Combined Sewer Overflows

a. General

The combined sewer overflows in the Boston Metropolitan area were addressed by consultants to the Metropolitan District Commission.

The combined sewer area within the MDC system is composed of a densely populated urban area supported by one of the oldest sewer collection systems in this country. Today, combined sewers serve about 50 percent of the MDC served population covering about one-fifth of the sewered area tributary to the MDC systems.

TABLE 14

REMOVALS OF CONSTITUENTS FROM SECONDARY EFFLUENT USING LAND TREATMENT METHODS

	Secondary Effluent mg/l	% Removal S.I.	R.I.
BOD	30	98+	90-95
COD	70	95+	90+
N	20	85+	75-80
P	10	99+	95+
Metals	-	95+	95+
Suspended Solids	30	99	99
Pathogens	-	99	99

LAND-ORIENTED ADVANCED WASTEWATER TREATMENT

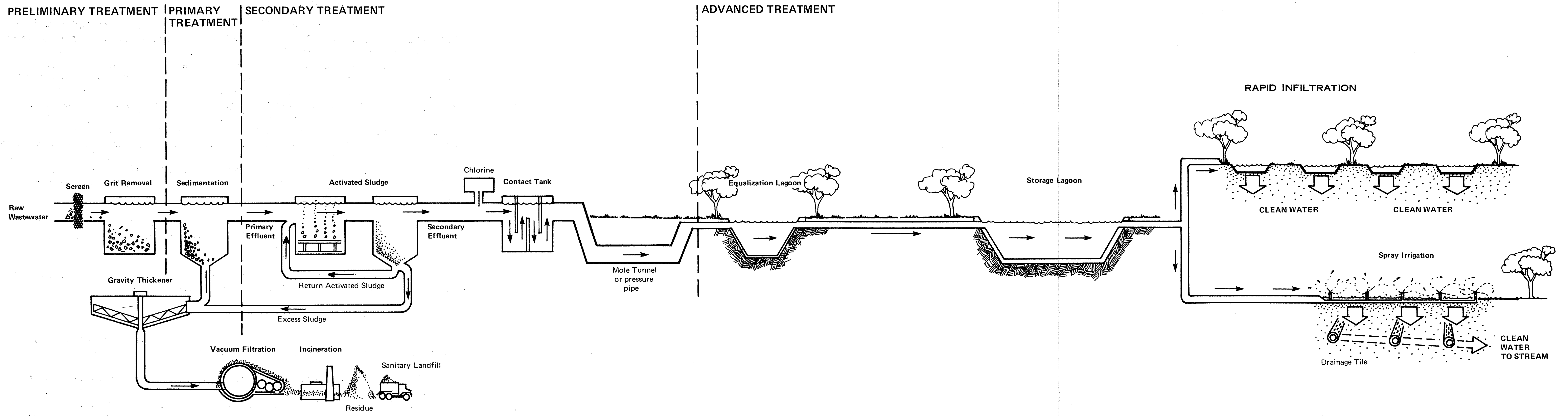


FIGURE 14

Land-Oriented Advanced Wastewater Treatment

Overflows of combined sewage occur in excess of 100 locations. The combined sewer area consists of all or parts of Boston, Brookline, Cambridge, Chelsea and Somerville.

b. Design Storm

Wet weather flow in combined sewer systems consists of storm runoff and normal dry weather flow. Hydraulically, storm runoff is by far the most significant component, therefore, the selection of the hydrologic basis for design is important. In the design of storm drains and combined sewers, extreme events are normally selected as the basis for sizing of pipes. Events of between 5 and 50 year severity have been used for such designs. For the regulation of combined sewer overflows, severities of such magnitude normally are not justified because the older combined systems normally do not have such transport capability; because the cost of regulating such flows increases drastically with severity, whereas relative pollution loads only increase slightly, and because during such hydrologically severe events, the receiving water usually acts quite differently than under normal dry weather flow conditions.

For the purposes of sizing facilities and estimating their cost in this study, a storm of one-year severity and six-hour duration was chosen as the design storm.

The combined sewers were modeled using the Environmental Protection Agency's Stormwater Management Model.

c. Overflow Regulation Objectives

At the present time, there exists no clearly defined criteria nationally on combined sewer overflow regulation.

However, it is expected that required correction of overflow problems will be defined in terms of meeting water quality standards. Therefore, the requirements for regulation of combined sewer overflows would vary from location to location depending on the nature of the receiving water and its intended use, but would not be subject to the "minimum secondary" criteria.

Determination of treatment requirements for each specific location is considerably more complex in the case of combined sewer overflows than for normal dry weather pollution due to the intermittent, storm-caused, nature of the discharge. Not only is the discharge highly variable in terms of flow, but also in terms of pollution concentrations. For example, the initial overflow normally contains a higher degree of pollution caused by the flushing of deposits in the sewers.

Also, the effects on the receiving stream are more complex in a combined sewer overflow regime due to both hydrologic and water quality slug loads. No longer can impacts on water quality be assessed purely on an average steady state basis, but must consider time varying effects. On the other hand, present water quality criteria are related to steady state conditions and do allow for the probability of not meeting criteria occasionally. How these criteria relate to the stormwater problem has yet to be decided.

For this study, the major objectives for regulation of combined sewer overflows are:

(1) Elimination of disease producing organisms,

(2) removal of floating matter, and

(3) reduction of solids.

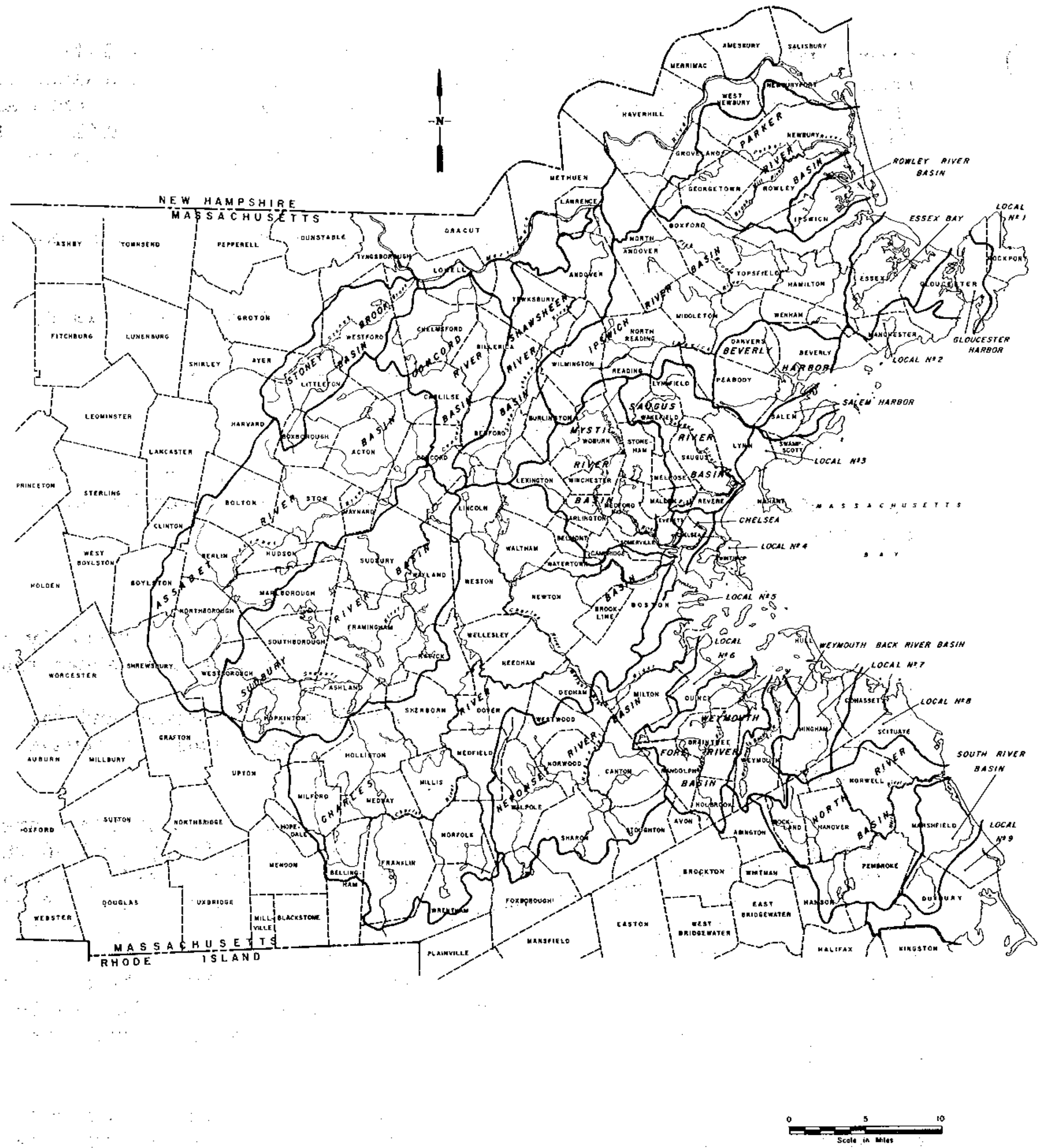
It is expected that removal of heavy metals and toxics will be through regulation of industrial discharges by source control.

4. <u>Urban Stormwater Runoff</u>

Although urban stormwater runoff has been traditionally regarded as nonpolluting to receiving waters, recent data have shown that such flows may contribute a major portion of the pollution load to streams. Runoff can have severe impacts on dissolved oxygen and may contribute considerably more pollution than a city's sanitary sewage during periods of moderate to heavy rain.

The Corps of Engineers as part of the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study studied the characteristics and magnitude of the pollution problem caused by urban stormwater runoff, and considered treatment alternatives that could reduce the pollution load. The study covered the drainage basins of the Eastern Massachusetts Metropolitan Area (see Figure 15) exclusive of the communities around Boston served by combined sewers. The entire effort is documented in Technical Data Volume 8 of the Wastewater Engineering and Management Plan for the Boston Harbor-Eastern Massachusetts Metropolitan Area.

The quantity and quality of urban stormwater runoff was estimated by a modified version of the Storage Treatment and Overflow Runoff Model (STORM) developed by Water Resources Engineers, Inc. for the Corps of Engineers Hydrologic Engineering Center. Only the runoff portion of the model was used. The runoff quantity and quality resulting from five design storms was determined for each community in each river basin. The design storms were "balanced" 24 hour storms. A "balanced" storm can be defined as rainfall sequence reflecting rainfall duration of a certain frequency. Three of the storms were 1,2, and 5 year return frequency storms. The other two storms were designated Class 90 and Class 95. These were synthetic storms of differing volumes and rainfall intensity.



WASTEWATER MANAGEMENT

NEWS

MERRIMACK RIVER BASIN-BOSTON METROPOLITAN AREA

RIVER AND DRAINAGE BASINS

EMMA STORMWATER

MANAGEMENT STUDY

FIGURE 15

To address stormwater problems in the study area, treatment systems with various combinations of storage, low rate microstraining, high rate microstraining and disinfection were developed. Storage is used primarily to equilibrate and attenuate the flow. Some settleable material is removed as a by-product. A microstrainer, which removes certain percentages of settleable solids, suspended solids and BOD, uses finely woven stainless steel mesh mounted on the periphery of a continuously revolving drum partially submerged in the waste stream. Design flow rates through microstrainers range from an optimum maximum treatment rate of 10 gpm/sf in low rate installations to 45 gpm/sf for high rate installations. A low rate microstrainer with storage is estimated to remove 95% of settleable solids, 65% of the suspended solids and about 40% of the biochemical oxygen demand, while high rate microstrainers remove 90%, 45% and 20% of these substances, respectively. Disinfection serves to reduce the level of bacterial contamination in the waste stream. This study proposed utilization of chlorine (sodium hypochlorite generated on site) as a disinfectant, at a dosage of 5 mg/l and a detention time of 15 minutes for the peak design flow rate.

F. Solutions and Impacts

1. Wastewater Treatment Alternatives

a. Water-Oriented Systems

Treatment processes developed by consultants to the MDC to meet requirements of Section 201 of the Federal Water Pollution Control Act Amendments of 1972 and comply with the Commonwealth of Massachusetts' Water Quality Standards are displayed in Figure 12. Secondary treatment was recommended for all ocean discharges, and advanced waste treatment was recommended for all discharges to inland waters.

Four water-oriented alternative treatment systems were designed to address the following concepts:

(1) Make improvements in only the existing Metropolital Sewerage District.

(2) Expand the district by 16 communities or delete some outlying communities.

(3) Expand the district to include all 109 communities in the study area.

(4) Eliminate the district and create a decentralized system with satellite facilities.

The configurations of these four alternatives and associated costs are displayed in Figures 16 through 19, and a more detailed description of each alternative is provided below.

(1) CONCEPT 1 - Upgrading Systems of the Existing Deer and Nut Island Treatment Plants Service Area

General - This plan follows the concept of upgrading the Metropolitan District sewerage facilities to provide for future needs within its present area, and utilizes regional and municipal systems to serve the remaining communities within the study area. There are several communities that would, however, become part of the Deer and Nut Islands treatment plant service area under this concept because no other reasonable solutions exist for them. The systems considered for servicing the remaining communities are based on retaining wastewater in the basin of origin.

Description of the Plan - Nut and Deer Islands wastewater treatment plants would ultimately serve 50 communities including the core Cities of Boston, Cambridge, Chelsea, Everett and Somerville. The existing Metropolitan District interceptors would be extended to provide service to the municipalities of Hopkinton, Lincoln, Lynnfield, Sharon and Weston since all of these communities are included because they are tributary to municipalities that are presently served by the Deer and Nut Islands treatment plants and because they cannot be reasonably included in any of their adjacent systems.

Figure 16 lists the municipalities that would be tributary wholly or in part to the Deer Island or Nut Island treatment plants, and displays suggested regional or municipal systems for the remaining 59 communities in the study area.

(2) CONCEPT 2 - Deer and Nut Islands Service Area Contraction

General - This concept would reduce the service area tributary to the Deer and Nut Islands treatment plants. This would be accomplished by creating 5 additional regional treatment systems within their present service area.

Description of the Plan - In this plan, the Deer and Nut Islands treatment plants would serve 32 communities include the core Cities of Boston, Cambridge, Chelsea, Everett and Somerville.

The remaining communities in the present Deer and Nut Islands treatment plants service area could be served as shown in Figure 17 and communities outside the present Deer and Nut Islands treatment plants service area would be served as in Concept 1, with the exception of the eastern part of Marlborough and Southborough. Under this concept and under Concept 3 and 4, the eastern part of Marlborough would remain as a municipal system, and Southborough would join a regional system in Framingham.

(3) CONCEPT 3 - Deer and Nut Islands Service Area Expansion

General - Concept 3, as shown in Figure 18, would extend the Deer and Nut Islands treatment plants service areas by increasing the present limits to generally include the Charles River basin in its entirety and communities around the present MDC water supplies in the Sudbury River basin. This extension would be accomplished by serving those communities that are not presently served and that are naturally tributary to the existing system. The plan does not extend service to those municipalities that are not naturally tributary to the existing system. The needs of these municipalities would be better provided for through developing regional and municipal systems within their drainage basins.

Description of the Plan - The Deer and Nut Islands wastewater treatment plants would serve 58 communities. Figure 18 lists these communities and indicates those that are tributary wholly or in part to the Nut Island or Deer Island treatment plants. In this concept, the system would be expanded to serve Hopkinton, Lincoln, Lynnfield, Sharon and Weston since these communities cannot be reasonably served by any other regional system. Further expansion would be achieved by incorporating into the system those communities that lie within the Upper Charles River basin and that are located around the present MDC water supply reservoir in the Sudbury River basin.

The remaining communities could be served as shown in Concept 1, with the exception of the eastern part of Marlborough.

(4) CONCEPT 4 - Decentralized Systems

General - This concept would decentralize the present system tributary to the Nut and Deer Islands treatment plants. This decentralization, shown in Figure 19, would be achieved by developing six additional regional systems within the present service area of the Metropolitan District System.

Description of the Plan - The Deer and Nut Islands wastewater treatment plants would serve 24 communities. Figure 19 lists the 24 communities and denotes those communities that are tributary wholly or in part to the Nut or Deer Islands treatment plants. This figure also sets forth the six additional regional systems that would be developed within the present Deer and Nut Islands service areas and the municipalities that they would serve.

The remaining communities within the study area could be served as shown in Concept 1, with the exception of the eastern part of Marlborough which would remain as a municipal system.

Technical Data Volume 4 of the Wastewater Engineering and Management Plan for the Boston Harbor-Eastern Massachusetts Metropolitan Area provides further detail on all these concepts. There is basically one suggested configuration for towns lying outside the proposed maximum expansion area of the Metropolitan Sewerage District as:

(a) It was a study goal to determine the ultimate size of the MSD. Engineering and management alternatives were developed for MSD service area proposed by the study.

(b) A State-EPA implementation plan already exists for many communities lying outside the study's proposed MSD service area.

(c) Areawide waste treatment management plans for the Boston Metropolitan Area authorized by Section 208 of PL 92-500, will address waste treatment management in outlying areas more fully.

b. Land-Oriented System

The U.S. Army Corps of Engineers developed a land application waste treatment alternative for the BH-EMMA study area. It is considered that the 1985 goal of eliminating discharge of pollutants into the navigable waters was addressed in the land-oriented portion of Concept No. 5.

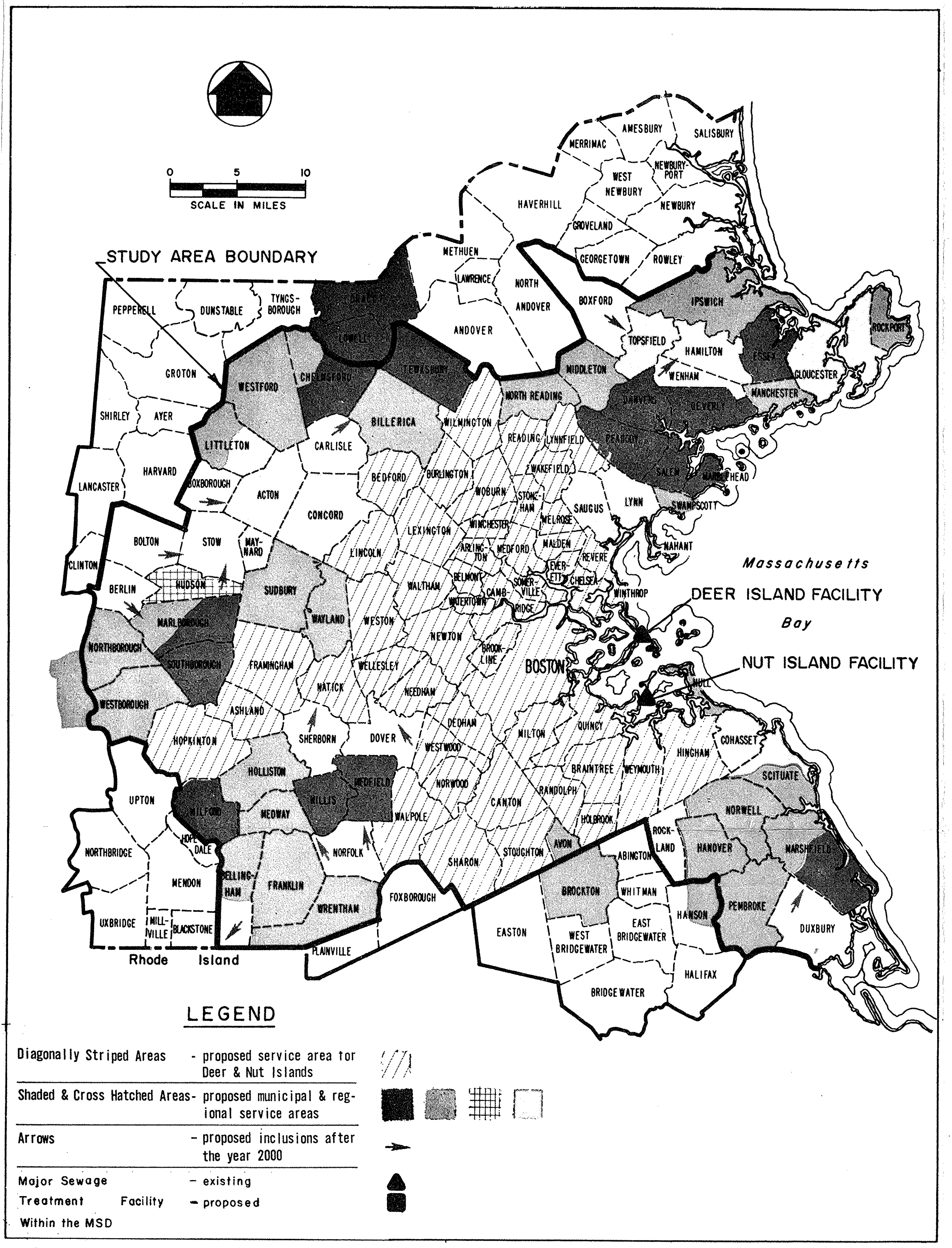
(1) Selection of Land Areas

In developing a land application alternative for renovation of municipal and industrial wastewater generated in the Eastern Massachusetts Metropolitan Area, the Corps of Engineers considered many factors. Some of the factors were: land use; geological characteristics of sites, both surficial and subsurface; and projected wastewater flows for the planning period.

The specific methodology used in the identification and sizing of potential land treatment sites included:

(a) Identification of recent land use for each community in the Eastern Massachusetts Metropolitan Area and the overall land use for all of Eastern Massachusetts.

(b) Collection and evaluation of available geologic information describing soils, geologic formations, and groundwater for Eastern Massachusetts with respect to land treatment techniques.



A POSSIBLE SET OF REGIONAL AND MUNICIPAL SYSTEMS OUTSIDE AREA SERVED BY DEER AND NUT ISLANDS TREATMENT PLANTS

Drainage basin	Municipality	Plant location
Saugus River	Lynn Nahant Saugus	Lynn
Bass, Danvers and North River	Beverly Danvers Marblehead Peabody Salem	Salem
North Coastal	Essex	Essex
	Gloucester	Gloucester (3 sites)
	Manchester	Manchester
	Rockport	Rockport
	Swampscott	Swampscott
Ipswich River	North Reading Middleton	Middleton
	Boxford (2000) Hamilton Topsfield Wenham (2000)	Hamilton
	Ipswich	Ipswich
Merrimack River	Chelmsford Tewksbury	Lowell
Concord River	Acton Boxborough (2000) Concord Littleton (part) Maynard	Concord
	Billerica Carlisle (2000)	Billerica
Stony Brook	Chelmsford Littleton (part) Westford	Chelmsford

Drainage basin	Municipality	Plant location
Sudbury River	Marlborough Southborough	Marlborough east
	Sudbury Wayland	Sudbury
Assabet River	Berlin (2000) Marlborough Northborough Shrewsbury Westborough	Marlborough west
	Bolton (2000) Hudson Stow (2000)	Stow
Upper Charles River	Bellingham Franklin Holliston Medway Norfolk (2000) Wrentham	Medway
	Medfield Millis Norfolk (2000)	Medfield
	Milford	Milford
North River	Hanover Norwell Pembroke Marshfield Scituate	Scituate
	Rockland	Rockland
Taunton River	Avon	Brockton
South Coastal	Scituate Cohasset	Cohasset
	Hull	Hull
	Marshfield Duxbury (2000)	Marshfield

MUNICIPALITIES TRIBUTARY TO DEER OR NUT ISLANDS WASTEWATER TREATMENT PLANTS UNDER CONCEPT 1

Tributary to Nut Island	Tributary to Deer Island
Ashland	Arlington
Boston (in part)	Bedford
Braintree	Belmont
Brookline (in part)	Boston (in part)
Canton	Brookline (in part)
Dedham	Burlington
Dover (after year 2000)	Cambridge
Framingham	Chelsea
Hingham	Everett
Holbrook	Lexington
Hopkinton	Lincoln
Milton (in part)	Lynnfield
Natick	Malden
Needham	Medford
Newton (in part)	Melrose
Norwood	Milton (in part)
Quincy	Newton (in part)
Randolph	Reading
Sharon	Revere
Sherborn (after year 2000)	Somerville
Stoughton	Stoneham
Walpole	Wakefield
Wellesley	Waltham
Westwood	Watertown
Weymouth	Weston
	Wilmington
	Winchester
	Winthrop
	Woburn

CAPITAL AND OPERATION COSTS *

A. Capital Costs

Deer and Nut Island WWTP service area improvements	
1. Deer Island WWTP	260
2. Nut Island WWTP	231
3. Pumping Stations	19
4. Interceptors - Present	118
- Future	47
Subtotal	675
Local share	67.5
Satellite area systems	
1. Treatment plants	31
2. Interceptors and pumping stations	20
Subtotal	51
Local share	5.1
Peripheral area systems	
1. Treatment plants	194
2. Interceptors and pumping stations	86
Subtotal	280
Local share	28.0
Grand total	
Complete cost	1006
Local snare	100.6

B. Operation and Maintenance Costs

Deer and Nut Island WWTP service areas	17
Satellite area systems	4
Peripheral area systems	17
Total annual operation and maintenance costs	38

* All costs are in millions of dollars

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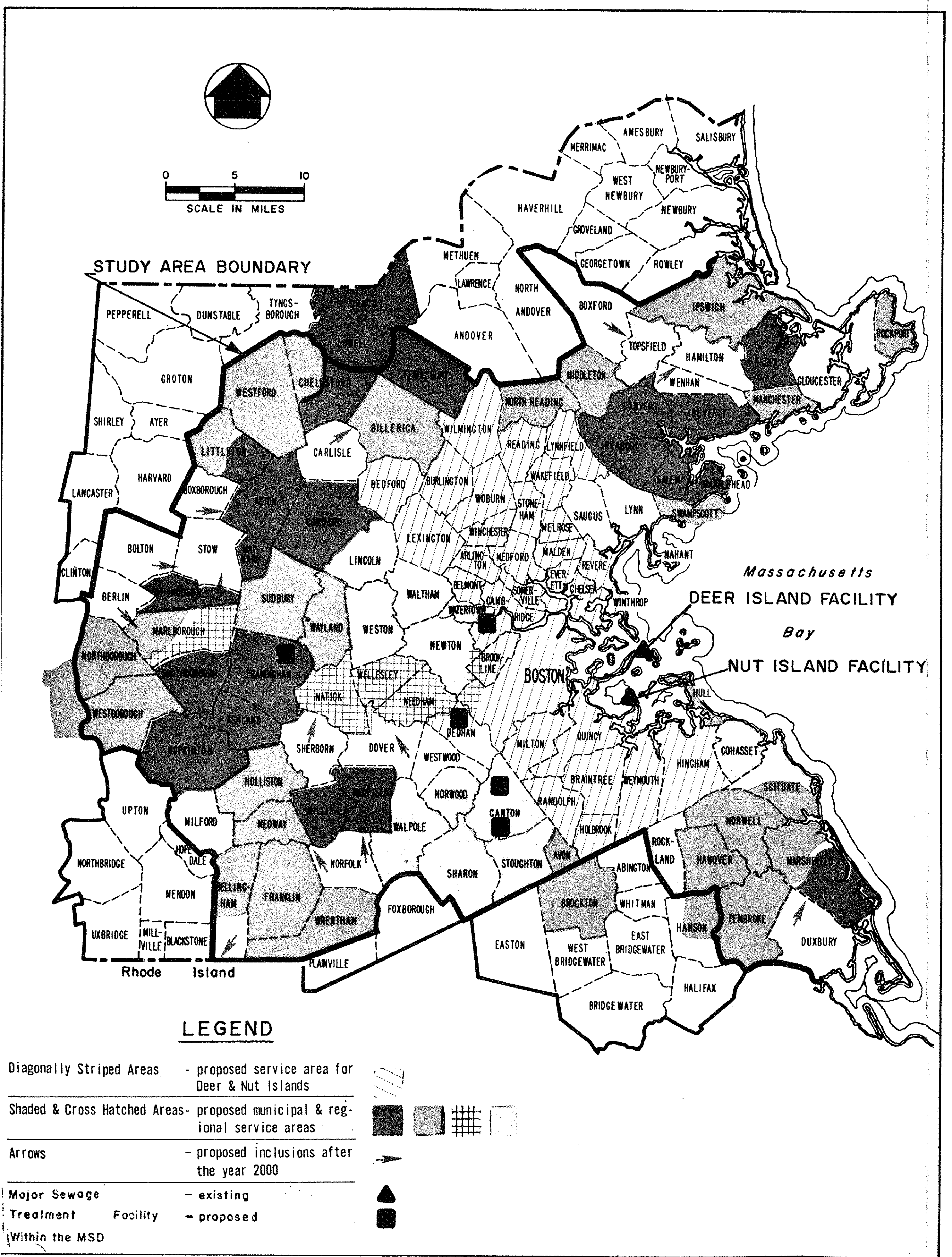
CONCEPT 1

UPGRADING SYSTEMS OF THE EXISTING DEER AND NUT ISLANDS SERVICE AREA

FIGURE 16



A POSSIBLE SET OF REGIONAL SYSTEMS WITHIN EXISTING DEER AND NUT ISLANDS SERVICE AREAS UNDER CONCEPT 2*

Drainage basins	Municipality	Plant location
Sudbury River	Ashland Framingham Hopkinton Southborough	Framingham
Charles River	Brookline (part of) Dedham (part of) Dover - combine with Dedham after 2000 Natick Needham Newton (part of) Sherborn (combine with Dedham after 2000 Wellesley Boston (part of)	Dedham
	Lincoln Newton (part of) Waltham Watertown Weston	Watertown
Neponset River	Canton (part of) Norwood (part of) Sharon Stoughton Walpole	Canton South
	Canton (part of) Dedham (part of) Norwood (part of) Westwood	Canton North

* In addition to systems outside Deer and Nut Island service areas, listed in Concept 1.

COMMUNITIES TRIBUTARY TO DEER OR NUT ISLANDS WASTEWATER TREATMENT PLANTS UNDER CONCEPT 2

Tributary to Nut Island	Tributary to Deer Island
Boston (in part)	Arlington
Braintree	Bedford
Brookline (in part)	Belmont
Dedham (in part)	Boston (in part)
Hingham	Brookline (in part)
Holbrook	Burlington
Milton (in part)	Cambridge
Newton (in part)	Chelsea
Quincy	Everett
Randolph	Lexington
Weymouth	Lynnfield
	Malden
	Medford
	Melrose
	Milton (in part)
	Reading
	Revere
	Somerville
	Stoneham
	Wakefield
	Wilmington
	Winchester
	Winthrop
	Woburn

CAPITAL AND OPERATION COSTS *

A. Capital Costs

Deer and Nut Island WWTP service area improvements	
1. Deer Island WWTP	236
2. Nut Island WWTP	135
3. Pumping Stations	19
4. Interceptors - Present	49
- Future	17
Subtotal	456
Local share	45.6
Satellite area systems	
1. Treatment plants	274
2. Interceptors and pumping stations	28
Subtotal	302
Local share	30.2
Peripheral area systems	
1. Treatment plants	194
2. Interceptors and pumping stations	86
Subtotal	280
Local share	28.0
Grand total	
Complete cost	1038
Local share	103.8

B. Operation and Maintenance Costs

Deer and Nut Island WWTP service areas	15
Satellite area systems	24
Peripheral area systems	17
Total annual operation and maintenance costs	56

*All costs are in millions of dollars

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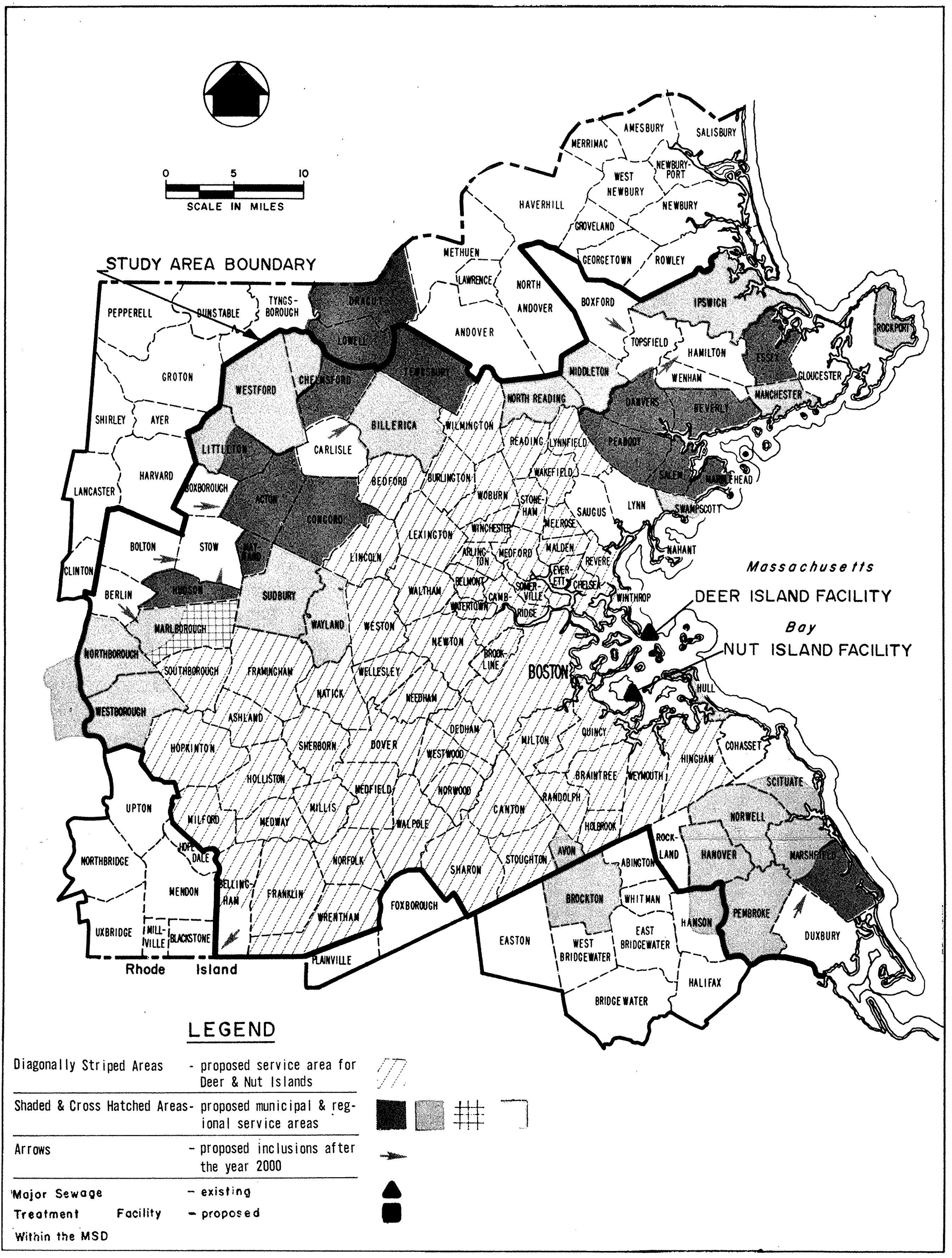
CONCEPT 2

DEER AND NUT ISLANDS SERVICE AREA CONTRACTION

FIGURE 17



COMMUNITIES TRIBUTARY TO DEER OR NUT ISLAND
WASTEWATER TREATMENT PLANTS UNDER CONCEPT 3

Tributary to Nut Island	Tributary to Deer Island
Ashland	Arlington
Boston (in part)	Bedford
Braintree	Belmont
Brookline (in part)	Boston (in part)
Canton	Brookline (in part)
Dedham	Burlington
Dover (after year 2000)	Cambridge
Framingham	Chelsea
Franklin	Everett
Hingham	Lexington
Holbrook	Lincoln
Holliston	Lynnfield
Hopkinton	Malden
Medfield	Medford
Medway	Melrose
Milford	Milton (in part)
Millis	Newton (in part)
Milton (in part)	Reading
Natick	Revere
Needham	Somerville
Newton (in part)	Stoneham
Norwood	Wakefield
Quincy	Waltham
Randolph	Watertown
Sharon	Weston
Sherborn (after year 2000)	Wilmington
Southborough	Winchester
Stoughton	Winthrop
Walpole	Woburn
Wellesley	
Westwood	
Weymouth	
Wrentham	

A POSSIBLE SET OF REGIONAL SYSTEMS OUTSIDE EXISTING DEER AND NUT ISLANDS
SERVICE AREAS UNDER CONCEPT 3

Drainage basin	Municipality	Plant location
Saugus River	Lynn Nahant Saugus	Lynn
Bass, Danvers and North River	Beverly Danvers Marblehead Peabody Salem	Salem
North Coastal	Essex	Essex
	Gloucester	Gloucester (3 sites)
	Manchester	Manchester
	Rockport	Rockport
	Swampscott	Swampscott
Ipswich River	North Reading Middleton	Middleton
	Boxford (2000) Hamilton Topsfield Wenham (2000)	Hamilton
	Ipswich	Ipswich
Merrimack River	Chelmsford Tewksbury	Lowell
Concord River	Acton Boxborough Concord Littleton (part) Maynard	Concord
	Billerica Carlisle (2000)	Billerica

Drainage basin	Municipality	Plant location
Stony Brook	Chelmsford Littleton (part) Westford	Chelmsford
Assabet River	Berlin (2000) Marlborough Northborough Shrewsbury Westborough	Marlborough west
	Bolton (2000) Hudson Stow (2000)	Stow
Sudbury River	Marlborough	Marlborough east
	Sudbury Wayland	Sudbury
North River	Hanover Norwell Pembroke Marshfield Scituate	Scituate
	Rockland	Rockland
Taunton River	Avon	Brockton
South Coastal	Scituate Cohasset	Cohasset
	Hull	Hull
	Marshfield Duxbury	Marshfield

CAPITAL AND OPERATION COSTS *

A. Capital Costs

Deer and Nut Island WWTP service area improvements

1. Deer Island WWTP	260
2. Nut Island WWTP	248
3. Pumping Stations	19
4. Interceptors - Present	160
- Future	138
Subtotal	825
Local share	82.5

Satellite area systems

1. Treatment plants	None
2. Interceptors and pumping stations	None
Subtotal	None
Local share	None

Peripheral area systems

1. Treatment plants	194
2. Interceptors and pumping stations	86
Subtotal	280
Local share	28.0

Grand total

Complete cost	1105
Local share	110.5

B. Operation and Maintenance Costs

Deer and Nut Island WWTP service areas	17
Satellite area systems	1
Peripheral area systems	17
Total annual operation and maintenance costs	35

*All costs are in millions of dollars

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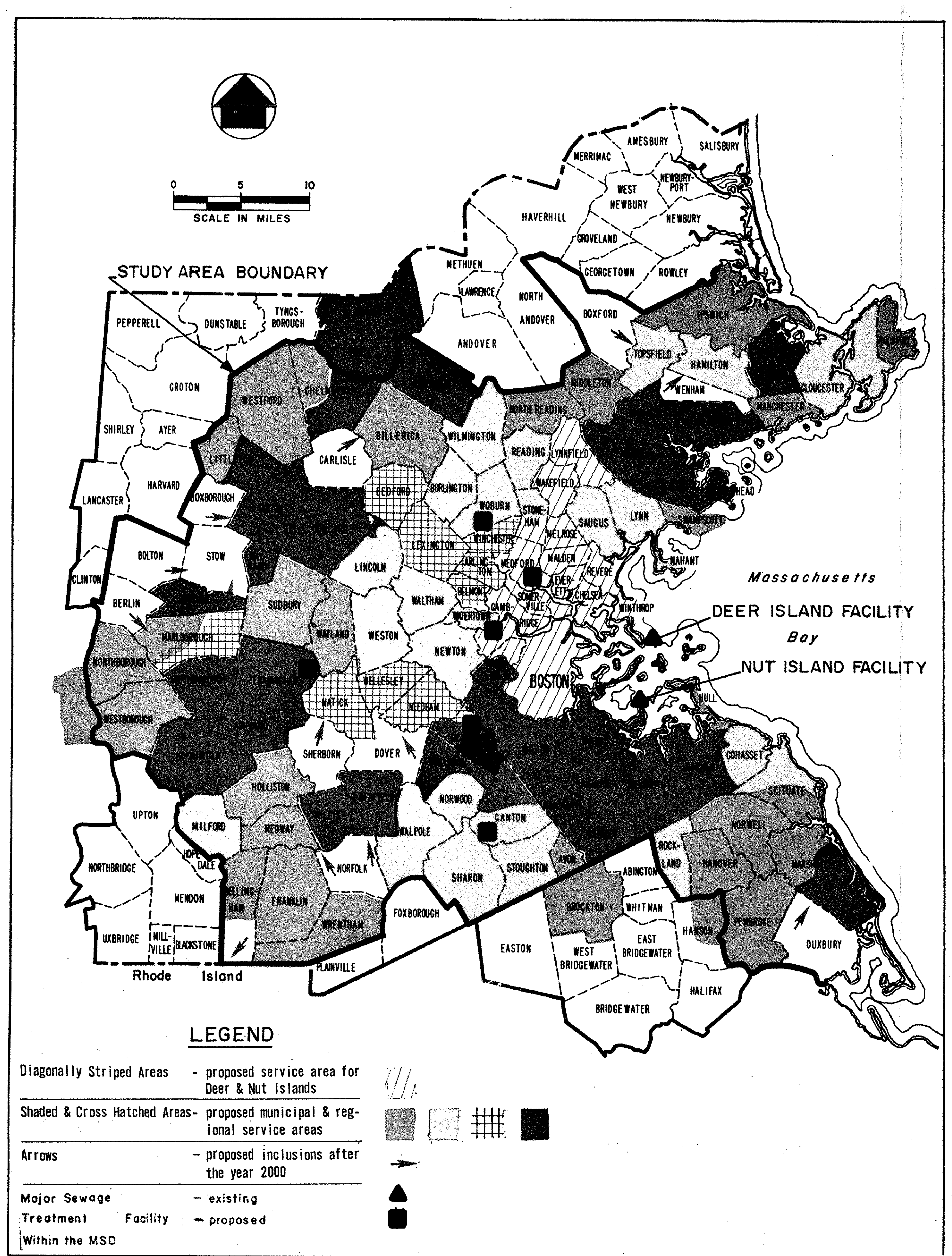
CONCEPT 3

DEER AND NUT ISLANDS SERVICE AREA EXPANSION

FIGURE 18



COMMUNITIES TRIBUTARY TO DEER OR NUT ISLANDS WASTEWATER TREATMENT PLANTS UNDER CONCEPT 4

Tributary to Nut Island	Tributary to Deer Island
Boston (in part)	Belmont (in part)
Brookline (in part)	Boston (in part)
Braintree	Brookline (in part)
Dedham (in part)	Cambridge
Hingham	Chelsea
Holbrook	Everett
Milton (in part)	Lynnfield
Newton (in part)	Malden
Quincy	Medford (in part)
Randolph	Melrose
Weymouth	Milton (in part)
	Revere
	Somerville
	Stoneham (in part)
	Wakefield (in part)
	Winthrop

A POSSIBLE SET OF REGIONAL SYSTEMS WITHIN EXISTING DEER AND NUT ISLANDS SERVICE AREAS UNDER CONCEPT 4*

Drainage Basin	Municipality	Plant Location
Sudbury River	Ashland Framingham Hopkinton Southborough	Framingham
Charles River	Dedham (part of) Dover Natick Needham Sherborn Wellesley	Dedham
	Lincoln Newton (part of) Waltham Watertown Weston	Watertown
Neponset River	Canton Norwood Sharon Stoughton Walpole Westwood	Canton
Mystic River	Burlington Reading Stoneham (part of) Wakefield (part of) Wilmington Winchester (part of) Woburn	Woburn
	Arlington Bedford Belmont (part of) Lexington Medford (part of) Winchester (part of)	Medford

*In addition to systems outside Deer and Nut Island service areas listed in Concept 1.

CAPITAL AND OPERATION COSTS*

A. Capital Costs

Deer and Nut Island WWTP service area improvements	
1. Deer Island WWTP	194
2. Nut Island WWTP	146
3. Pumping Stations	19
4. Interceptors - Present	57
- Future	15
Subtotal	431
Local share	43.1
Satellite area systems	
1. Treatment plants	381
2. Interceptors and pumping stations	31
Subtotal	412
Local share	41.2
Peripheral area systems	
1. Treatment plants	194
2. Interceptors and pumping stations	86
Subtotal	280
Local share	28.0
Grand total	
Complete cost	1123
Local share	112.3

B. Operation and Maintenance Costs

Deer and Nut Island WWTP service areas	14
Satellite area systems	33
Peripheral area systems	17
Total annual operation and maintenance costs	64

*All costs are in millions of dollars

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CONCEPT 4

DECENTRALIZED SYSTEM

FIGURE 19

(c) Identification of those areas in Eastern Massachusetts potentially suitable for land treatment of wastewaters.

(d) Determination of acreages needed for land treatment of projected year 2000 flows using either spray irrigation or rapid infiltration.

(e) Comparison of lands potentially available with acreage needed.

This procedure revealed that the potential for land application within the Eastern Massachusetts Metropolitan Area is limited by the small amount of land sites available. Some 10,000 acres were identified as having potential for land treatment. The majority of this acreage was in the southwestern part of the Eastern Massachusetts Metropolitan Area. Some spray irrigation and rapid infiltration sites were found in coastal communities north and south of Boston Harbor. Only two potential spray irrigation sites were larger than 300 acres, the remainder were less than 300 acres and rather fragmented. The potential rapid infiltration sites were generally 100 acres or less and highly fragmented.

Potential land treatment sites in excess of 49,000 acres were identified in southeastern Massachusetts. Many of these sites were well clustered in three areas: Fall River - Freetown, Plymouth - Carver, and western Cape Cod. This area then seemed to hold the greatest potential for a land treatment system.

(2) Formulation of the Plan

Cognizant of the existing sewerage system within the Boston Harbor-Eastern Massachusetts Metropolitan Area, the Corps of Engineers chose to accept Concept 4 as developed by the Metropolitan District Commission's consultant as the basis for formulating a land application concept.

Of the 109 communities in the study area, only seven communities belonging to three proposed regional or municipal wastewater treatment systems appeared to have the opportunity to implement land application within their region; (1) Hamilton, Boxford, Topsfield, Wenham; (2) Ipswich; (3) Middleton, North Reading. The Hamilton system has adequate lands to implement either spray irrigation or rapid infiltration, while the others had sufficient acreage only for rapid infiltration.

The remaining proposed regional units in the Boston Harbor-Eastern Massachusetts study area were either too highly urbanized with large wastewater flows or were less populated communities with lands not suited for wastewater treatment according to the design criteria used. In either case, the projected 2000 effluent flows from the regional treatment facilities were too large to receive treatment using the lands identified within the regional sewage treatment units. For this reason, suitable lands in southeastern Massachusetts outside the Boston Harbor-Eastern Massachusetts Metropolitan Area were considered as to their plausible use for either the spray irrigation or rapid infiltration-land treatment method.

The land alternative developed by the U.S. Army Corps of Engineers proposes that wastewater flows from five regional treatment facilities, proposed in Concept 4, be transported to southeastern Massachusetts for land application. These five facilities are: the Canton facility in the Neponset River Basin; the Dedham and Watertown facilities in the Charles River Basin; and the Woburn and Medford facilities in the Mystic River Basin. Wastewater flows from other regional units in Concept 4 were not chosen for land application for the following reasons:

(a) Diversion of all wastewater flows from the Sudbury-Assabet-Concord River Basin (SUASCO) could have serious impact upon the streamflow and aquatic environment. This would be especially critical during low flow periods if the projected year 2000 effluent flows, about 38 mgd, from the six proposed regional treatment facilities (Billerica, Concord, Sudbury, Hudson, Marlborough (east and west),) in the SUSASCO Basin were diverted outside the basin. This volume would be greater than the 7-day - 10-year low flow in the Concord River at the confluence with the Merrimack River at Lowell, Massachusetts.

(b) Similarly, diversion of the projected year 2000 effluent flows from the proposed upper Charles River treatment facilities in Milford, Medway and Medfield would cause negative impacts to the squatic environment stemming from reduced streamflow.

(c) Chemical analysis of the wastewater flows to the Deer and Nut Island treatment facilities show a substantial proportion of these flows are made up of saline water. Because of hazards to crop production, soil properties and groundwater quality beneath land treatment sites, treatment of saline wastewater effluents on the land is not a practical consideration. For this reason, land treatment of some 466 mgd, from the regional wastewater treatment plants proposed, under construction or on-line at Salem, Lynn, Deer Island, Nut Island, Hull, Swampscott and Marshfield (part) was not proposed.

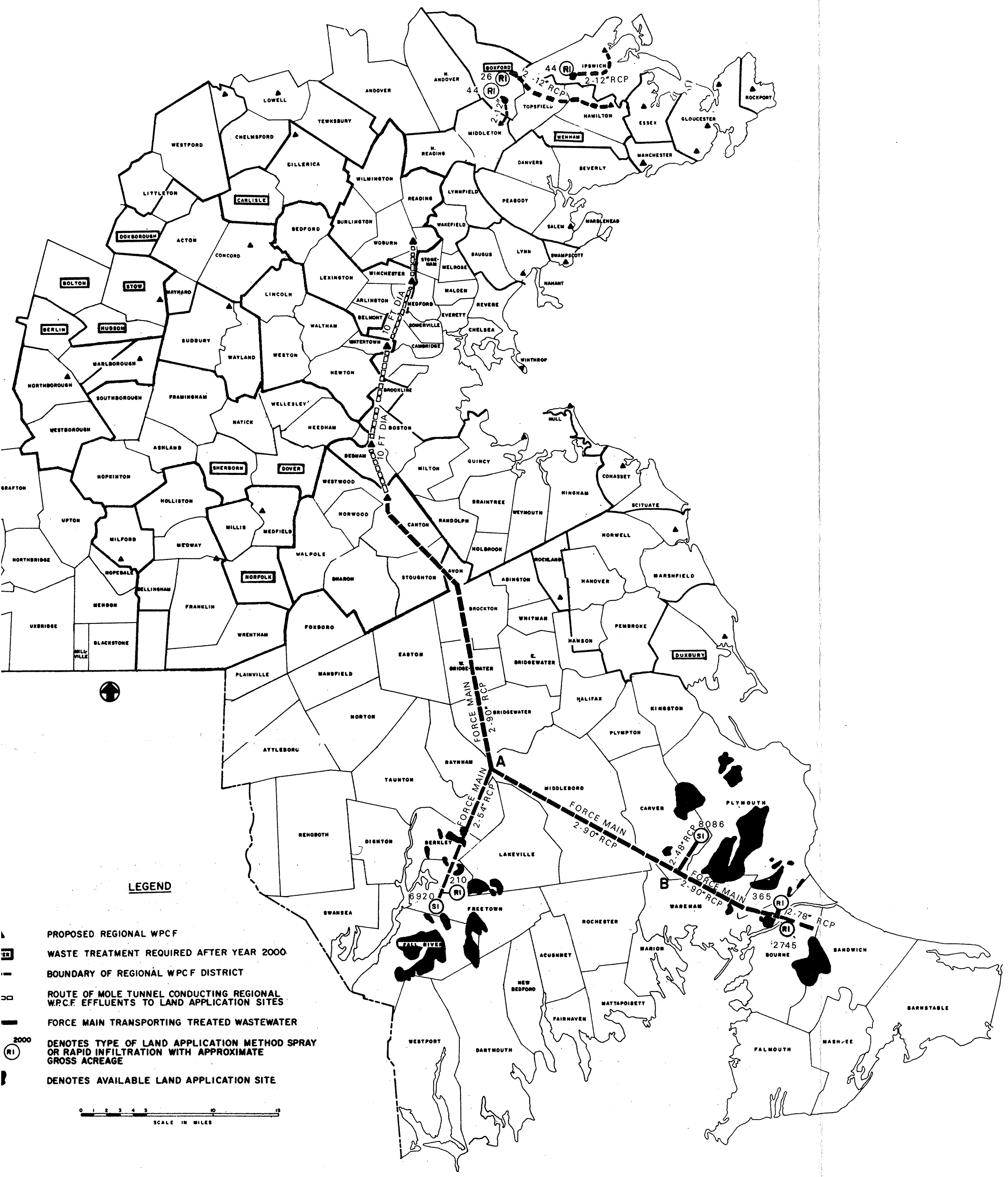
The Corps of Engineers proposed that projected wastewater flows of 177 mgd from 29 communities serviced by the Canton, Dedham, Watertown, Medford and Woburn facilities be diverted to southeastern Massachusetts for land application because (1) sufficient land areas suited to land treatment in Canton, Dedham, Medford, Watertown or Woburn regional wastewater treatment units were not found, and (2) the impact of diversion of wastewater flows outside of river basins in which these facilities are located was not believed as crucial a consideration as diversions from other river basins. Wastewater flows from all or most of the area included within these five regional units are currently directed to either the Deer or Nut Island treatment facilities for discharge into Boston Harbor.

Figure 20 displays the land-oriented alternative with land application sites in southeastern Massachusetts (approximately 18,700 acres) and in the north coastal region (approximately 190 acres). Costs associated with this alternative are also shown.

It was proposed that all facilities participating in the land application system employ secondary treatment, as depicted in Figure 14. The remaining water-oriented facilities would employ treatment methods as proposed in Concept 4. Effluent from the Canton, Dedham, Watertown, Medford, and Woburn facilities would be transported in a southerly direction, via a mole tunnel, to equalizing storage lagoons in Canton. From Canton, the effluent would be pumped through force mains to storage lagoons in Freetown, Plymouth and Bourne. Storage lagoons at each of these sites would be large enough to store flows when rainy or cold weather interferes with land application. The storage capacity for spray irrigation sites would be 26 weeks, and for rapid infiltration sites would be 14 weeks. However, it is believed that the mild climate of southern Massachusetts will enable land application by rapid infiltration to continue on a year round basis. Sludge from the 5 regional secondary facilities in the southeastern Massachusetts system would be thickened and stored at each plant, and conveyed via pipeline to Dedham plant to be dewatered by vacuum filtration and incinerated in a multiple hearth incinerator. Resultant ash would be lagooned and then transported to sanitary landfills.

c. Development of the Preferred Plan

These five concepts were presented to the public for comment through the study's public participation program, and impact analyses were performed by consultants to the Army Corps of Engineers (see Section d). After considering public response and the results of impact analyses, the Technical Subcommittee for the BH-EMMA study met in December 1974 to select the study's preferred alternative. Each member of the Technical Subcommittee voiced their preferences for one of the five proposed concepts or a modification of one of these concepts. Two alternatives for the "preferred" concept were presented. One alternative was for advanced waste treatment facilities in Canton on the Neponset River, in Dedham on the Charles River and in Framingham on the Sudbury River. The other alternative was an advanced waste treatment facility in Canton, and a basin diversion of the Framingham facility flow to an advanced treatment facility in the Middle Charles River area. Both preferences included three advanced waste treatment facilities on the Upper Charles in Medway, Milford and Medfield.



COMMUNITIES TRIBUTARY TO DEER OR NUT ISLANDS
WASTEWATER TREATMENT PLANTS UNDER CONCEPT 5

Tributary to Nut Island	Tributary to Deer Island
Boston (in part)	Belmont (in part)
Brookline (in part)	Boston (in part)
Braintree	Brookline (in part)
Dedham (in part)	Cambridge
Hingham	Chelsea
Holbrook	Everett
Milton (in part)	Lynnfield
Newton (in part)	Malden
Quincy	Medford (in part)
Randolph	Melrose
Weymouth	Milton (in part)
	Revere
	Somerville
	Stoneham (in part)
	Wakefield (in part)
	Winthrop

A SET OF REGIONAL SYSTEMS SERVED BY
LAND APPLICATION SYSTEMS

Drainage basin	Municipality	Plant Location
Sudbury River	Ashland Framingham Hopkinton Southborough	Dedham
Charles River	Dedham (part of) Dover Natick Needham Sherborn Wellesley	Dedham
Charles River	Lincoln Newton (part of) Waltham Watertown Weston	Watertown
Neponset River	Canton Norwood Sharon Stoughton Walpole Westwood	Canton
Mystic River	Burlington Reading Stoneham (part of) Wakefield (part of) Wilmington Winchester (part of) Woburn	Woburn
Mystic River	Arlington Bedford Belmont (part of) Lexington Medford (part of) Winchester (part of)	Medford
Ipswich River	Ipswich	Ipswich
Ipswich River	Hamilton Topsfield	Hamilton
Ipswich River	Middleton North Reading	Middleton

CAPITAL AND OPERATION COSTS*

A. Capital Costs

Deer and Nut Island WWTP service area improvements

1. Deer Island WWTP	194
2. Nut Island WWTP	146
3. Pumping Stations	19
4. Interceptors - Present	57
- Future	15
Subtotal	431
Local share	43.1

Land application systems

1. Treatment plants	140
2. Interceptors and pumping stations	380
3. Land systems	111
Subtotal	631
Local share	63.1

Peripheral area systems

1. Treatment plants	176
2. Interceptors and pumping stations	86
Subtotal	262
Local share	26.2

Grand total

Complete cost	1324
Local share	132.4

B. Operation and Maintenance Costs

Deer and Nut Island WWTP service areas	14
Land application systems	8
Peripheral area systems	16
Total annual operation and maintenance costs	38

*All costs are in millions of dollars

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CONCEPT 5

LAND ORIENTED PLAN

FIGURE 20

A vote was then taken for the preferred concept on a facility by facility basis. Satellite advanced waste treatment facilities on the Upper Charles and in Canton, Woburn, Dedham, Framingham and on the Middle Charles received the most votes. It was then agreed that the recommended alternative would include three advanced facilities on the Upper Charles, an advanced facility in Canton, a small (2 mgd) advanced facility on the Aberjona River in Woburn for flow augmentation purposes, and either advanced facilities in Framingham and Dedham, or a facility on the Middle Charles. It was also decided that proposed facilities serving peripheral towns (see Concepts 1-5) would receive no further discussion or recommendations since these towns would not be included in the study's proposed Metropolitan Sewerage District Area. It was voted that the subcommittee meet again to determine the final configuration of the preferred alternative.

Impact analyses were performed by the various consultants on the proposed Middle Charles facility (see Section d). Two reports that had a large impact on the decision for the Middle Charles treatment facility were an open-file report by the U.S. Geological Survey entitled "Groundwater Management, Charles River Basin, Massachusetts" and a report by the U.S. Army Corps of Engineers entitled "The Potential Effects of Wastewater Treatment Alternatives on the Flow of the Concord River below River Meadow Brook at Lowell." The report on the Charles River Basin predicted that if the Towns of Dedham, Needham, Wellesley and part of Natick meet their projected 1990 water demands with water derived from the basin, and if, after use, all their water is sewered out of the basin, the flow of the Charles River at Waltham can be expected to approach zero for approximately 9 days during an average year. Also, if the maximum monthly demand is expected to be 1.2 times greater than the average demand and is expected to occur when streamflow is lowest, the flow of the river will be expected to approach zero for approximately 14 days during an average year.

The Corps' report on the Concord River predicted that, assuming the continuation of present water supply and wastewater management trends, by the year 2000, the flow of the Concord River will, on the average, be slightly higher during low flow times than at present.

In January 1975, the Technical Subcommittee met, and considering the consultant's impact analyses voted that the Middle Charles facility be part of the preferred alternative. Maintenance of adequate flow in the Charles River was considered more important than avoidance of adverse impacts that could potentially result from the discharge of advanced treatment effluent into the middle portion of the Charles River.

Details of the Preferred Alternative and other study recommendations are discussed in Section H.

A summary of the total estimated Capital, Operating and Maintenance Costs for each plan is provided below:

No.	Concept Type	Capital Cost	Annual Oper. & Maint. Cost
1	Water-Oriented	$1,006,000,000	$38,000,000
2	Water-Oriented	$1,038,000,000	$56,000,000
3	Water-Oriented	$1,105,000,000	$35,000,000
4	Water-Oriented	$1,123,000,000	$64,000,000
5	Combination Land and Water-Oriented	$1,324,000,000	$38,000,000

d. Impact Assessment

Impact assessment may be defined as the analysis and evaluation of change resulting from the implementation of a specified "plan action", or component of an alternative engineering system.

Impact analysis is the measurement of the change against a baseline condition. It involves categorization and identification of significant environmental, economic, and social changes; identification of duration of these changes; and measurement of the magnitude of these changes.

Impact evaluation is the determination of change as beneficial, adverse or neutral (and making trade-offs amongst these changes) in accordance with community goals and objectives as well as with the Federal objectives, expressed in the Water Resource Council's Principles and Standards, of National Economic Development, Environmental Quality, Social Well-Being and Regional Development.

In the BH-EMMA study, six impact disciplines were identified:

(1) Aesthetic
(2) Biological
(3) Engineering
(4) Hygienic
(5) Institutional-Financial
(6) Socio-Economic

The Corps of Engineers contracted four individual consultants to perform biological, hygienic, socio-economic and aesthetic impact analysis. Engineering and financing and management impact assessment was carried out by consultants to the MDC.

Each impact discipline was divided into several impact categories or topics in which effects could be measured. Categories in each discipline are listed below:

<u>Aesthetic</u> - (Visual-cultural and design)
regional land use plans
local land use plans
adjacent development
adjacent landscape
environment (water and air quality, noise, odor, etc.)

<u>Biological</u> - Instream quality
groundwater
aquatic environment
terrestrial environment

<u>Hygienic</u> - water supplies
recreation areas
shellfish harvesting areas

<u>Socio-Economic</u> - land use
population and housing
industrial activity
recreation
commercial activity
agriculture and forestry
municipal finance
employment and income

First, each consultant established a baseline condition for each category within a particular impact discipline. Then, the effects of each alternative concept on the impact categories were analyzed in terms of both magnitude and duration (short or long term). Where possible, mitigation measures were suggested to alleviate adverse effects. Finally, impacts were evaluated with the respect to Federal objectives, expressed in the Water Resource Council's <u>Principles and Standards</u> of National Economic Development, Environmental Quality, Social Well-Being and Regional Development.

A summary of impact analyses and an evaluation of each of the study's alternatives beneficial and adverse effects on Federal objectives is provided in Table 15.

2. <u>Combined Sewer Overflows</u>

The regulation and control of combined sewer overflows was addressed by consultants to the Metropolitan District Commission. A variety of approaches, including separation and housekeeping were examined. Until recently, only two general approaches to combined sewer overflow regulation in the Boston Harbor area were developed.

TABLE 15 BOSTON HARBOR-EASTERN MASSACHUSETTS WASTEWATER MANAGEMENT STUDY-SUMMARY OF IMPACT ANALYSES

OBJECTIVES		IMPACTS COMMON TO ALL ALTERNATIVES	CONCEPT 1	CONCEPT 2	CONCEPT 3	CONCEPT 4	PREFERRED PLAN	THE LAND-ORIENTED ALTERNATIVE CONCEPT 5
NATIONAL ECONOMIC DEVELOP-MENT	Beneficial:	Commercial Activity: Increases commercial activity and recreation related services.						Agriculture: Increases productivity of land which could potentially be used for forage crops.
	Adverse:	Manufacturing: Product prices in major industrial categories will increase due to added treatment costs.	Monetary Cost:* Capital Cost = $726M Annual O&M Costs = $ 21M * Costs do not include peripheral systems.	Monetary Cost: Capital Cost = $731M Annual O&M Costs = $ 39M	Monetary Cost: Capital Cost = $825M Annual O&M Costs = $ 18M	Monetary Cost: Capital Cost = $798M Annual O&M Costs = $ 47M	Monetary Cost: Capital Cost = $735M Annual O&M Costs = $ 29M	Monetary Cost: Capital Cost = $825M Annual O&M Costs = $ 21M
ENVIRON-MENTAL QUALITY	Beneficial:	Water Quality: Improves water quality in Boston Harbor. Eliminates non-point sources of pollution. May reduce stimulus to eutrophication on Upper Charles River.	Terrestrial Environment: 1 facility site is visually compatible with surrounding environment. Water Quality: Creates a more stable aquatic environment on the Upper Charles.	Terrestrial Environment: 2 facility sites are visually compatible with surrounding environment. 2 facility sites preserve and enhance open space. Water Quality: Creates a more stable aquatic environment on the Upper Charles, Neponset and Sudbury Rivers.		Terrestrial Environment: 2 facility sites are visually compatible with surrounding environment. 2 facility sites preserve and enhance open space. Water Quality: Creates a more stable aquatic environment on the Upper Charles, Neponset, Sudbury and Aberjona Rivers.	Terrestrial Environment: 1 facility site is visually compatible with surrounding environment. Water Quality: Creates a more stable aquatic environment on the Upper Charles, Neponset and Aberjona Rivers.	Terrestrial Environment: 2 facility sites are visually compatible with surrounding environment. Provides water to a dry area, increasing vegetative growth and variety and groundwater levels in southeastern Massachusetts. Water Quality: Creates a more stable aquatic environment on the Upper Charles.
	Adverse:	Terrestrial Environment: Sewers encroach on wetlands along wetlands. Water Quality: Degrades water quality due to decrease in forested land and increased runoff. Aesthetic Values: Disrupts historical landmarks on Deer Island.	Terrestrial Environment: 2 facilities disrupt surrounding ecology. Aesthetic Values: 3 facilities are visually incompatible with surrounding development and landform. Commitment of Resources: Deer and Nut Island facilities discharge 555 MGD of potentially recycleable wastewater to Boston Harbor (year 2000).	Terrestrial Environment: Reduces shore zones on the Neponset, leading to undesirable vascular plants. 4 facilities disrupt surrounding ecology. Water Quality: Produces chloramine concentrations that may be toxic to aquatic life on the Neponset, Middle Charles and Sudbury Rivers. Stimulates eutrophication in the Neponset, Middle Charles and Sudbury Rivers. Aesthetic Values: 5 facilities are visually incompatible with surrounding development and landform. Commitment of Resources: Deer and Nut Island facilities discharge 435 MGD of potentially recycleable wastewater to Boston Harbor (year 2000).	Terrestrial Environment: 2 facilities disrupt surrounding ecology. Water Quality: Creates less suitable habitat for aquatic life on the Charles River due to flow reduction. Aesthetic Values: 2 facilities are visually incompatible with surrounding development and landform. Commitment of Resources: Deer and Nut Island facilities discharge 575 MGD of potentially recycleable wastewater to Boston Harbor (year 2000).	Terrestrial Environment: Reduces shore zones on the Neponset, leading to undesirable vascular plants. 3 facilities disrupt surrounding ecology. Water Quality: Produces chloramine concentrations that may be toxic to aquatic life on the Aberjona, Mystic, Neponset, Middle Charles and Sudbury Rivers. Stimulates eutrophication in the Mystic, Aberjona, Neponset, Middle Charles and Sudbury Rivers. Aesthetic Values: 5 facilities are incompatible with surrounding development and landform. Commitment of Resources: Deer and Nut Island facilities discharge 385 MGD of potentially recycleable wastewater to Boston Harbor (year 2000).	Terrestrial Environment: Reduces shore zones on the Neponset River, leading to undesirable vascular plants. 3 facilities disrupt surrounding ecology. Water Quality: Produces chloramine concentrations that may be toxic to aquatic life on the Aberjona, Neponset and Middle Charles Rivers. Stimulates eutrophication in the Aberjona, Neponset and Middle Charles Rivers. Aesthetic Values: 4 facilities are incompatible with surrounding development and landform. Commitment of Resources: Deer and Nut Island facilities discharge 500 MGD of potentially recycleable wastewater to Boston Harbor (year 2000).	Terrestrial Environment: 3 facilities disrupt surrounding ecology. May damage cranberry bogs. Water Quality: May degrade local surface or groundwater supplies, in event of system malfunction. Aesthetic Values: 5 facilities are incompatible with surrounding development and landform. Commitment of Resources: Deer and Nut Island facilities discharge 385 MGD of potentially recycleable wastewater to Boston Harbor (year 2000). Removes much used woodlands.
REGIONAL DEVELOP-MENT	Beneficial:	Population: Extension of interceptors encourages growth of population and development in Charles and SUASCO watersheds with trend towards lower population densities in core area.	Employment: Increased construction employment of 52,680 man-months for Deer and Nut Islands and satellite facilities.	Employment: Increased construction employment of 72,980 man-months for Deer and Nut Islands and satellite facilities. Population: Canton facility creates population distribution consistent with regional and local development proposals.	Employment: Increased construction employment of 55,200 man-months for Deer and Nut Islands and satellite facilities.	Employment: Increased construction employment of 72,705 man-months for Deer and Nut Islands and satellite facilities. Creates most O&M jobs.	Employment: Increased construction employment of 62,830 man-months for Deer and Nut Islands and satellite facilities. Population: Canton facility creates population distribution consistent with regional and local development proposals.	Employment: Increased construction employment of 72,705 man-months for Deer and Nut Islands and satellite facilities. Creates most O&M jobs. Population: Is compatible with plans for expansion of public open space.
	Adverse:	Employment: 155 industrial jobs may be lost due to added treatment costs.	Population: 2 facilities are incompatible with regional and local development proposals.	Population: 2 facilities are incompatible with regional and local development proposals.		Income: Largest decrease in personal income due to increased taxes.	Population: 2 facilities are incompatible with regional and local development proposals.	Income: Withdraws land from housing market. Population: 2 facilities are incompatible with regional and local development proposals.
SOCIAL WELL-BEING	Beneficial:	Public Health: Creates better community health through elimination of non-point source, pollution and presently inadequate waste treatment facilities. Improves quality of shellfish harvesting and recreational areas in coastal waters due to improved waste treatment. Housing: Extension of interceptors will help to satisfy housing demand in Charles and SUASCO watersheds. Availability of sewers would mitigate reasons against construction of low and moderate income housing.	Recreation: Increases recreational opportunities due to improved water quality and/or increased flow: Boston Harbor, Upper Charles River. 1 facility site creates a new recreation area.	Community Well-Being: Augments flow of Neponset and Charles creating more pleasant conditions. Recreation: Increases recreational opportunities due to improved water quality and/or increased flow: Boston Harbor and Neponset, Upper Charles and Sudbury Rivers. 2 facility sites create new recreation areas. 2 facility sites on Neponset River encourage access to existing recreation areas.	Recreation: Increases recreational opportunities due to improved water quality and/or increased flow: Boston Harbor. 1 facility site creates a new recreation area.	Community Well-Being: Augments flow of Neponset, Charles and Mystic, creating more pleasant conditions. Recreation: Increases recreational opportunities due to improved water quality and/or increased flow: Boston Harbor, Upper Charles, Neponset, Mystic and Sudbury Rivers. 2 facility sites create new recreation areas.	Community Well-Being: Augments flow of Neponset, Charles and Mystic, creating more pleasant conditions. Recreation: Increases recreational opportunities due to improved water quality and/or increased flow: Boston Harbor, Upper Charles, Neponset and Mystic Rivers. 2 facility sites create new recreation areas.	Public Health: Soil provides better removal of hazardous substances than advanced treatment. Recreation: Increases recreational opportunities due to improved water quality and increased flow: Boston Harbor. 2 facility sites create new recreation areas. Increases acreage of publicly controlled land.
	Adverse:	Public Health: Larger collection systems and facilities cause greater health hazards when malfunctioning. Housing: Expansion of Nut Island facility may cause loss of housing.	Community Well-Being: Effluent discharge will increase nitrate concentrations on Upper Charles River creating unpleasant conditions and hazards to water supply wells. Construction may cause neighborhood disruption at 2 harbor facility sites. Recreation: 3 facility sites conflict with present and potential open space and recreation uses.	Community Well Being: Effluent discharge will increase nitrate concentrations in Neponset, Charles and Sudbury Rivers creating unpleasant conditions and hazards to water supply wells. Construction may cause neighborhood disruption at 2 harbor facility sites. Public Health: Effluent discharge may increase virus concentrations in Neponset, Middle Charles and Sudbury Rivers. Recreation: 5 facility sites conflict with present and potential open space and recreation uses.	Community Well-Being: Lowers flow in Charles River, causing unpleasant conditions. Construction may cause neighborhood disruption at 2 harbor facility sites.	Community Well-Being: Effluent discharge will increase nitrate concentrations in Neponset, Charles, Mystic, Aberjona and Sudbury Rivers creating unpleasant conditions and hazards to water supply wells. Construction may cause neighborhood disruption at 2 harbor and Woburn facility sites. Public Health: Effluent discharge may increase virus concentrations in Neponset, Middle Charles, Mystic, Aberjona and Sudbury Rivers. Recreation: 5 facility sites conflict with present and potential open space and recreation uses.	Community Well-Being: Effluent discharge will increase nitrate concentrations in Neponset, Charles and Aberjona Rivers creating unpleasant conditions and hazards to water supply wells. Construction may cause neighborhood disruption at 2 harbor and Woburn facility sites. Public Health: Effluent discharge may increase virus concentrations in Neponset, Middle Charles and Aberjona Rivers. Recreation: 5 facility sites conflict with present and potential open space and recreation uses.	Public Health: Lagoons and application sites may breed vectors of disease and nuisances. Breakdown in soils removal efficiency may contaminate water supplies and recreation areas. Possible contamination of air by aerosol-borne pathogens. Recreation: 5 facility sites conflict with present and potential open space and recreation uses. Reduces recreational usefulness of state forest areas in southeastern Massachusetts. Community Well-Being: Construction may cause neighborhood disruption at 2 harbor and Woburn facility sites.

a. Consolidation of overflows at partial treatment facilities to limit pollution in immediate need areas.

b. Large scale collection and diversion of overflows for deep ocean discharge, thereby eliminating pollution from the combined sewer overflows.

The first approach is a decentralized handling of combined sewer overflows which permits peacemeal implementation in accordance with criteria and needs of each immediate area and provides flexibility for inclusion of future technologies in treatment beyond that presently provided.

The second approach is the other extreme of complete centralization and requires an early commitment to the entire plan. It prevents all stormwater and pollution that reaches sewers from discharging into immediate Boston Harbor waters and diverts it to Massachusetts Bay following screening and chlorination.

Various alternatives between these two approaches were investigated and are presented in the following discussion.

Alternative 1: Decentralized Overflow Regulation

Alternative 1 proposes to consolidate 58 combined sewer outfalls into 10 groups. Each group of outfalls would be connected by conduits which would transport overflows to a regulation facility for treatment and discharge to the receiving waters.

Each of the regulation systems would have the following major components:

(1) Collection conduits
(2) Tank
(3) Pumping facilities
(4) Outfall

Collection Conduits. The collection conduits would be sized to divert design flows to the tanks. For purposes of preliminary cost estimates, pipes and conduits were sized to carry peak overflows generated by the Stormwater Management Model. In cases where large pipes were needed through densely developed areas, costs were developed for tunneling as well as for open cut construction and the lower of the costs was used.

Tanks. The tanks would receive overflow from the collection conduits. Each tank would be divided into two bays for flexibility of operation. Flow would be delivered first to one bay in each of the tanks. As this bay is filled, a floating scum and oil baffle would rise with the liquid surface to maximize capture of such materials.

Depending on the magnitude of a storm event, flow would then pass into a transfer channel for distribution to the second bay, or additional flow could be bypassed to the second bay permitting retention of the first flush in bay one. When the entire basin is filled, overflows would pass to the receiving stream. Using the design storm flow data, the basin cross-section and configuration would be designed to optimize velocity and settling conditions within the available volume of storage. Screens would be installed between an effluent scum baffle and the overflow weirs to polish the overflow before discharge to the river.

The flow would be disinfected by the introduction of chlorine upstream from the tanks. The tanks would be designed to provide 15 minutes detention for the peak design flow.

Pump Station. Each regulation facility would have pumps capable of pumping the peak design flow.

The overflow captured in the detention tanks and the solids and floatables retained would be dewatered into the interceptor system for eventual treatment at Deer Island treatment plant. Dewatering would be accomplished either by gravity or by pumping. Either system would be controlled by the available capacity in the receiving interceptor.

Outfall. The outfalls from the 10 regulation facilities as proposed have been located in the vicinity of the tanks. However, a detailed analysis of the receiving waters would determine if alternative outfall locations should be selected.

Alternative 2: Moon Island Tunnel Plan

In Alternative 2, seven of the regulation facilities in Alternative 1 would be retained. Three of the regulation facilities would be replaced by a tunnel plan consisting of:

(1) Surface transmission lines
(2) Deep hard rock tunnels and junction chamber
(3) Pump station and return sludge system
(4) Chlorination - detention facilities
(5) Outfall

A network of transmission lines would collect the overflows from combined sewers tributary to the:

(1) East Side Interceptor
(2) Dorchester Brook Conduit
(3) South Boston Interceptor (North and South)
(4) Dorchester Interceptor above Victory Road

The transmission lines would transport overflows via headworks to one of three tunnels. These tunnels would meet at a junction chamber below Columbus Cricle where a fourth tunnel would transport the flow to a pump station at Moon Island. The flow would then be pumped into tanks at Moon Island. Retained flows and wastes would be returned to the interceptor system for treatment at the Deer Island treatment plant.

Alternative 3: Modified Moon Island Plan

Alternative 3 is a variation in the handling of Dorchester Bay overflows. Two tanks would be combined into a single system centered around a tank at Columbus Point and the existing Moon Island facilities would be upgraded. Facilities included are:

(1) Stormwater collection conduits in South Boston and Dorchester
(2) Tanks at Columbus Point and on Moon Island
(3) Upgraded Calf Pasture Pumping Station
(4) Return sludge system
(5) Outfall

The stormwater collection conduits in South Boston and Dorchester would divert flows to the vicinity of Columbus Circle. The flows would then be combined and routed to the Calf Pasture pumping station to be pumped through the Dorchester Bay tunnel to Moon Island. The Moon Island tanks would be upgraded with chlorination and screening facilities and overflows would be treated and discharged to the harbor. Flows in excess of the transport system capacity would be diverted to an adjacent tank for treatment and discharge. On this basis, the first flush would not be discharged to the shoreline tank.

Captured flows and wastes at the Moon Island and Columbus Point facilities would be returned to the MDC interceptor system at Columbus Park for transmission to the Deer Island treatment plant.

Cost Summary

The total construction and operation costs for each alternative are summarized in Table 16.

3. Urban Runoff

a. Quality and Quantity

As described in Section E(4), each community and watershed was analyzed through the use of the STORM model. Predicted concentrations and mass of suspended and settleable solids, biochemical oxygen demand (5 day), total nitrogen, and orthophosphate in the runoff were determined for each design storm for the actual and projected land use conditions of 1970, 2000, 2020 and 2050.

TABLE 16

SUMMARY OF CAPITAL AND OPERATION AND MAINTENANCE COSTS FOR COMBINED SEWER OVERFLOW REGULATION ALTERNATIVES

Alternative	Capital Cost(1) (million dollars)	Operation & Maintenance Cost(1) (million dollars per year)
1	279	3.9
2	299	3.7
3	307	3.8

(1) January 1975 costs (ENR 2200).

A sample data sheet presenting hourly pollutant concentrations and loads (mass) contributed by the Town of Canton during the 1-year storm event under the 2020 projected land use conditions is shown on Figure 21.

An analysis of the relationship of the storm runoff and pollutant runoff was performed. The analysis showed that 90 to 95 percent of the 5-day BOD and suspended solids were contained in the storm runoff preceding the maximum flow rate for the set of assumptions under which the data was generated. This showed that the storm runoff was producing a "flushing" effect and that much of the pollutional matter would arrive at the receiving stream in about 12 hours after the start of the 24-hour balanced design storm.

Figure 22 shows the relationship of two mass pollutographs to the storm hydrograph for the Town of Canton. As shown by the figure, the storm peak flow of the hydrograph occurred about 12 hours after the start of the 1-year balanced storm. The mass curve plots for BOD and suspended solids show that approximately 95% of these pollutants are contained in the flow up to the time of the peak. The volume of runoff up to the time of the peak flow is about 68% of the total runoff volume. These values are typical of the STORM model output for all communities in the study area.

Figure 23 shows the relationship between storm class or frequency and pollutant discharges. As shown by the figure, the total pounds of suspended solids discharged from the drainage area ranged from 34.5% for the Class 90 storm, to 99% for the 1-year return frequency storm, to 100% for the 5-year storm. Similarly, the 5-day BOD discharged from the community varied from 52.5% for the Class 90

EVENT NO. 3 - 1-YEAR STORM

TOWN AND WATERSHED CANTON - NEPONSET RIVER 2020

TOTAL AREA OF TOWN IN WATERSHED 12083 ACRES (URBAN LAND AREA = 6664)

	SINGLE-FAMILY RESIDENTIAL(SFR)	MULTI-FAMILY RESIDENTIAL(MFR)	COMMERCIAL (COMM)	INDUSTRIAL (IND)	URBAN OPEN LAND
PCNT IMPERVIOUSNESS	25	45	60	80	10
TOTAL ACRES	2750	1874	880	792	368
LENGTH OF STREET GUTTERS (FT/ACRE)	400	500	400	350	250
STREET SWEEPING INTERVAL (DAYS)	60	14	14	14	60

STORM RAINFALL (MINUS .06IN. LOSS TO DEPRESSION STORAGE),HUNDREDTHS OF INCHES
0 0 0 2 4 7 8 8 10 17 30 95 27 13 10 8 8 7 3 2 2 1 1 1

COMPUTED RUNOFF COEFFICIENT 0.45716
ANTECEDENT DRY DAYS 5

INTERVAL	SUSPENDED SOLIDS (LBS)	SUSPENDED SOLIDS (MG/L)	SETTLEABLE SOLIDS (LBS)	SETTLEABLE SOLIDS (MG/L)	B O D (LBS)	B O D (MG/L)	NITROGEN (LBS)	NITROGEN (MG/L)	PHOSPHATE (LBS)	PHOSPHATE (MG/L)	RUNOFF (CFS)
4	229.	16.5	9.	0.6	163.	11.8	27.	1.95	3.	0.19	61.
5	551.	19.9	19.	0.7	302.	10.9	55.	1.99	6.	0.20	123.
6	1190.	24.6	35.	0.7	464.	9.6	98.	2.03	10.	0.20	215.
7	1402.	25.4	40.	0.7	430.	7.8	103.	1.85	11.	0.18	246.
8	1349.	24.4	40.	0.7	344.	6.2	91.	1.64	10.	0.16	246.
9	1810.	26.2	53.	0.8	362.	5.2	111.	1.61	12.	0.16	307.
10	3840.	32.7	117.	1.0	563.	4.8	213.	1.81	22.	0.18	522.
11	7894.	38.1	315.	1.5	919.	4.4	412.	1.99	42.	0.20	922.
12	20263.	30.9	2523.	3.8	2126.	3.2	1044.	1.59	105.	0.16	2918.
13	96.	0.5	55.	0.3	12.	0.1	6.	0.03	1.	0.00	829.
14	25.	0.3	15.	0.2	3.	0.0	2.	0.02	1.	0.00	399.
15	16.	0.2	10.	0.1	2.	0.0	1.	0.01	1.	0.00	307.
16	11.	0.2	6.	0.1	2.	0.0	1.	0.01	1.	0.00	246.
17	10.	0.2	8.	0.1	2.	0.0	1.	0.01	1.	0.00	246.
18	8.	0.2	6.	0.1	1.	0.0	1.	0.01	1.	0.00	215.
19	3.	0.1	3.	0.1	1.	0.0	1.	0.01	1.	0.00	92.
20	2.	0.1	2.	0.1	1.	0.0	1.	0.01	1.	0.00	61.
21	2.	0.1	2.	0.1	1.	0.0	1.	0.01	1.	0.00	61.
22	1.	0.1	1.	0.1	1.	0.0	1.	0.01	1.	0.00	31.
23	1.	0.1	1.	0.1	1.	0.0	1.	0.01	1.	0.00	31.
24	1.	0.1	1.	0.1	1.	0.0	1.	0.01	1.	0.00	31.
TOTAL	38692.		3254.		5689.		2161.		216.		
SFR	5947.		493.		874.		328.		33.		
MFR	11996.		1003.		1763.		702.		69.		
COM	13740.		1149.		2023.		732.		76.		
IND	5944.		519.		873.		341.		33.		
OPN	1066.		86.		157.		59.		6.		
TOTAL	38692.		3254.		5689.		2161.		216.		

Figure 21. Example of "STORM" Model Computer Program Data

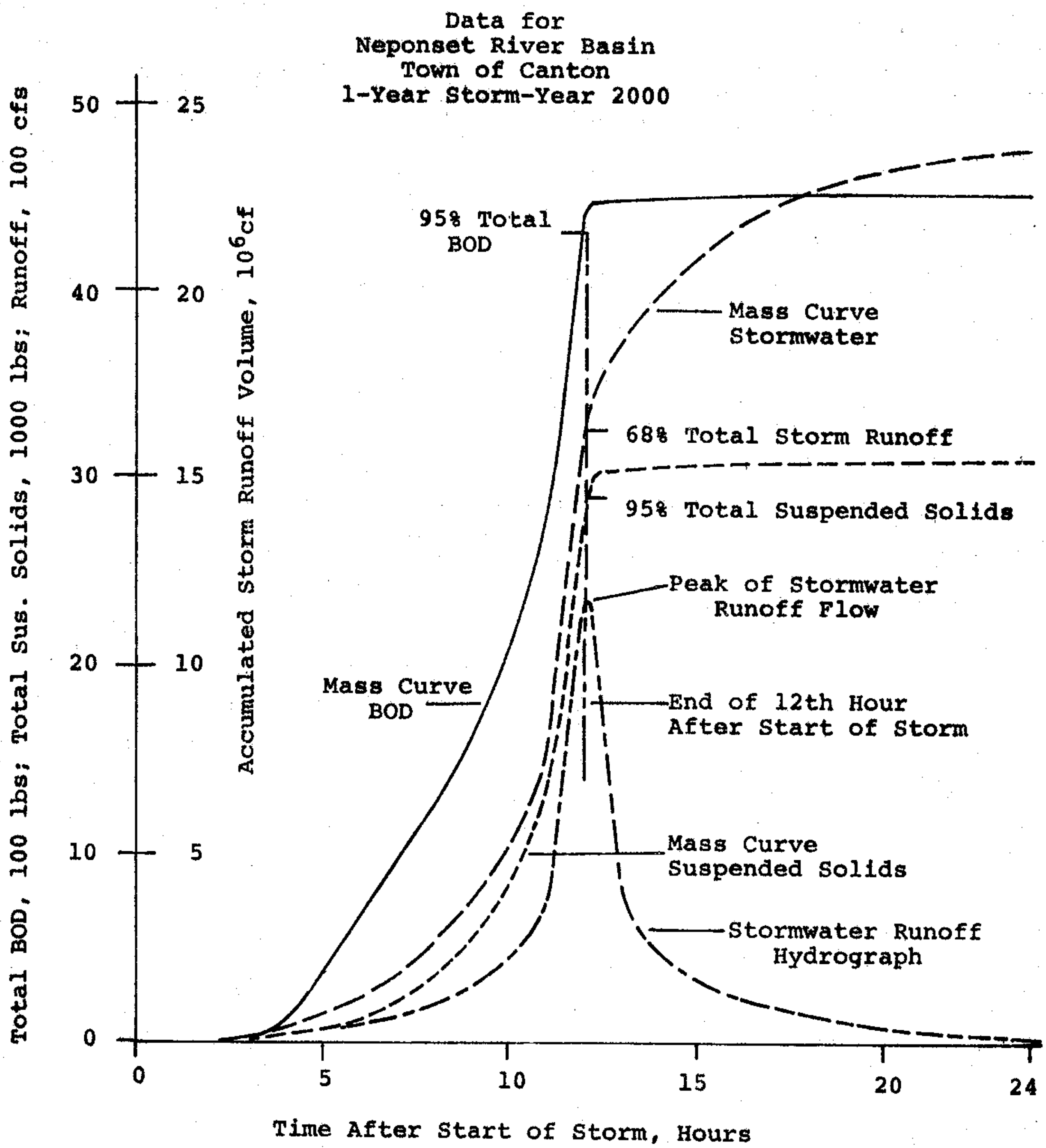


FIGURE 22. Stormwater Runoff-Pollutograph Relationships

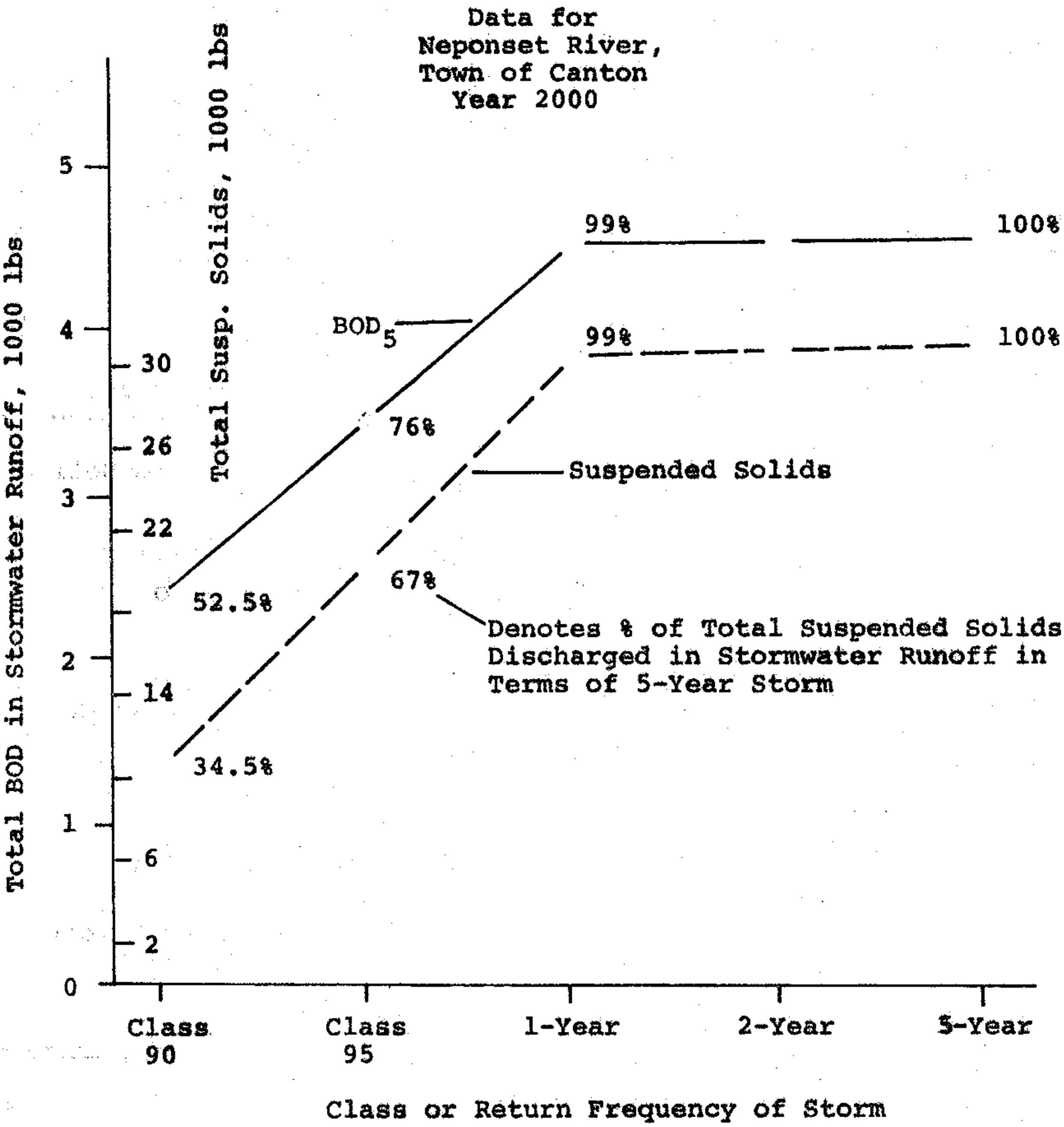


FIGURE 23. Relationships Between Storms and Pollutant Discharges

storm, to 99% for the 1-year storm, to 100% for the 5-year storm. This indicates that the maximum discharge of pollutants from storm runoff can be expected from a 1-year storm for all practical purposes. The peak runoff from a drainage area for a given duration storm can be expected to occur at the same time from the start of the storm, regardless of the storm class or frequency. The best cost-effective storm management would probably be obtained by treating all of the storm flow up to the volume before the peak flow rate for the 1-year balanced storm. This will insure that 90-95% of the major pollutants, i.e. BOD and suspended solids, will be retained in storage for subsequent treatment. The 1-year balanced storm was selected as the design storm for this effort.

b. Stormwater Management Alternatives

Four stormwater management alternatives were developed for use in the Boston Harbor-Eastern Massachusetts Metropolitan Area after examination of the watersheds and the pollutograph characteristics. Alternatives 2-4 are shown schematically in Figure 24.

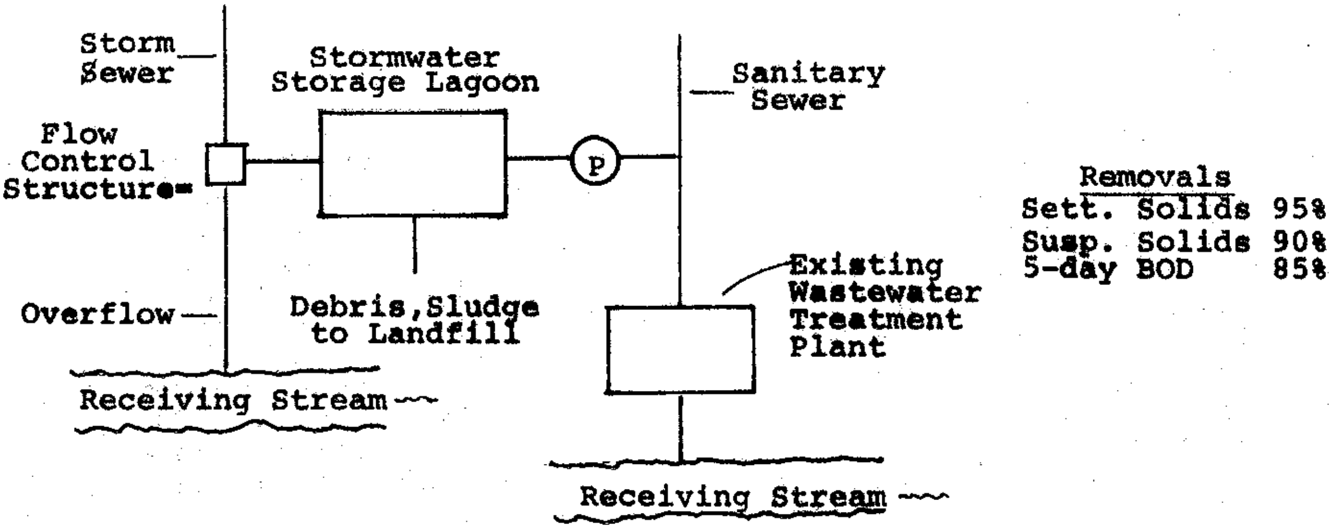
Alternative 1: No Treatment

Alternative No. 1 is to be used where the drainage area is relatively small and the amount of pollutional matter is insignificant and relatively harmless. This situation usally occurs where fringe towns are overlapped by two or more watersheds. Because such watershed overlapping of a town's area takes place at the highest elevation in the watershed, the tributary area of interest must then be drained by a small stream which later joins the main watershed drainage stream. It was assumed that small streams probably exert little pollutional effect on larger rivers, hence, the "no treatment" alternate was established. Careful land use policy could extend use of this alternate for some time in the future.

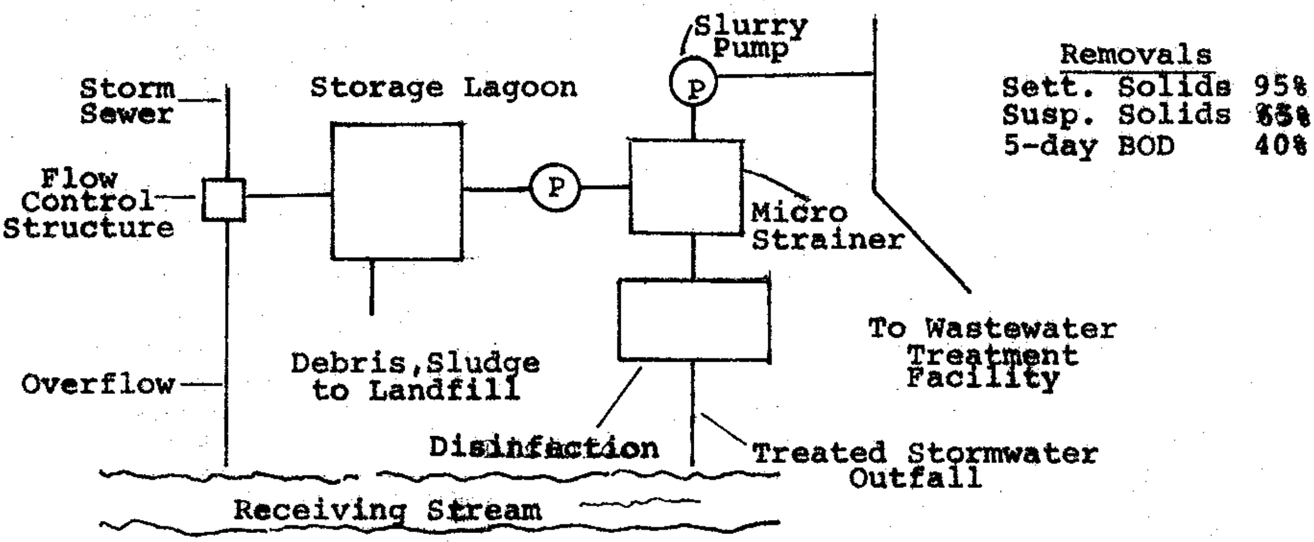
Alternative 2: Storage and Pumping

In many areas it may be possible to simply store the stormwater runoff immediately following a storm and to pump it later to an existing wastewater treatment facility for treatment. This alternative is next in line to alternative 1 as far as cost is concerned. Since many communities within the study area have sanitary sewers, this alternate should receive first consideration wherever stormwater treatment is required. Of course, the existing wastewater treatment facility should have sufficient treatment capability to handle the stormwater it receives, although such treatment may be performed during periods of low flow at the plant over a 3 to 4 day period.

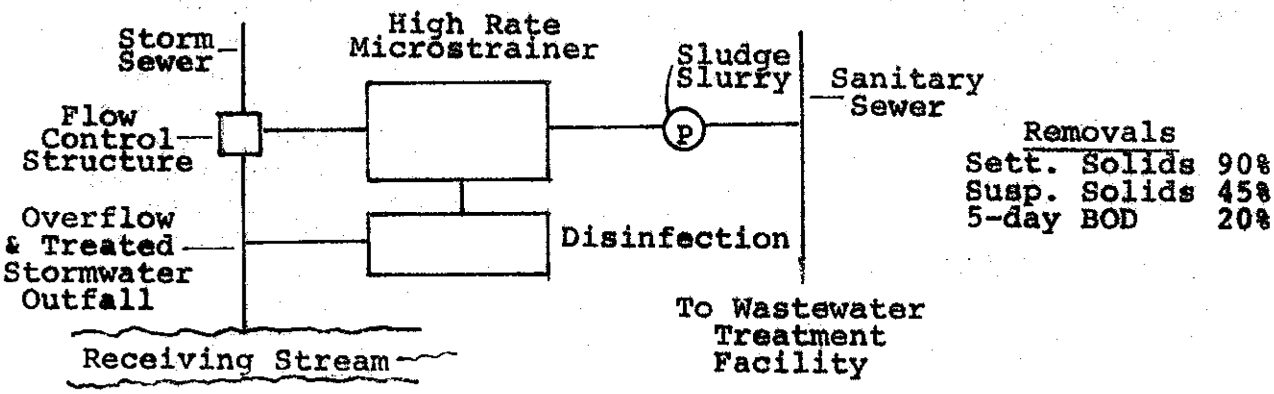
In the event that the treatment plant capacity is relatively small, consideration should be given to expanding the treatment capacity of the plant. Pollutant removals will be similar to those



ALTERNATIVE 2: STORAGE & PUMPING



ALTERNATIVE 3: STORAGE, FILTRATION & DISINFECTION



ALTERNATIVE 4: HIGH RATE FILTRATION & DISINFECTION

FIGURE 24. Schematic Diagrams for Stormwater Treatment Alternatives

normally experienced at the facility which are assumed to be as indicated in Figure 24.

Alternative 3: Storage, Filtration and Disinfection

In the event that Alternative 2 cannot be employed, a stormwater treatment facility may be provided. The facility should be able to remove a reasonable amount of pollutional matter, however, in view of the high storm runoff that has to be treated and the requirement that such stormwater treatment should proceed automatically with no manpower attendance, the facility should be simple in design and operational requirements. As shown by Figure 24, stormwater is first stored, then taken from storage at a constant rate and passed through a microstrainer. The flow is then disinfected and discharged to the receiving stream.

Figure 24 also presents estimates regarding pollutant removals. These estimates represent a general consensus of removal rates as given by the literature. The storage lagoon is assumed to provide some treatment through sedimentation.

Alternative 4: High Rate Filtration and Disinfection

The best way to achieve reasonable stormwater treatment costs is to incorporate storage with treatment. In some situations, however, this may not be possible, especially when land for stormwater storage is limited or very expensive. Alternative 4 is designed to handle the incoming stormwater flow rate on a variable flow basis by providing high-rate microstraining filtration plus disinfection. The pollutant removals for this alternative are not as high as they are for Alternative 3 because of the absence of the storage facility which aids considerably in the treatment of stormwater. Figure 24 indicates estimates of pollutant removals using this alternative.

The stormwater management requirements for each community were determined. The most likely alternatives for each community were designed and costed for the design year 2000. Table 17 presents the data for the Town of Canton in the Neponset River Basin. The most viable alternative for each community was selected and the costs were summarized for the entire study area. The costs are summarized in Table 18.

c. Effects on Receiving Streams

The disposal of untreated stormwater with its concomitant pollutants can have deleterious effects on the water quality in streams. Conversely, the removal of these pollutants can have salubrious effects on receiving streams albeit such benefits may be difficult to quantify or specify precisely. In general, however, the state of the streams would be greatly improved; it would become clearer,

TABLE 17

STORMWATER MANAGEMENT ALTERNATIVES

TOWN OF CANTON
NEPONSET RIVER BASIN

		Alternative 2	Alternative 3
URBAN DRAINAGE AREA			
DESIGN YEAR	2000		
ACRES	5311		
TOTAL STORM RUNOFF VOL.			
MIL. GAL.	172.2		
TOTAL STORMWATER POLLUTANTS			
SETT. SOLIDS, LBS.	2606		
SUSP. SOLIDS, LBS.	30928		
BOD_5	4547		
STORMWATER TREATMENT			
TREAT. DESCRIP.		SP	SMD
VOLUME TREAT., MG		116.4	116.4
% TREATED		67.6	67.6
POLLUTANT REMOVALS			
SETT. SOLIDS, LBS.		2475.7	2475.7
SUSP. SOLIDS, LBS.		27835.2	20103.2
BOD_5, LBS.		3865	1818.8
POLLUTANTS DISCHARGED			
SETT. SOLIDS, LBS.		130.3	130.3
SUSP. SOLIDS, LBS.		3092.8	10824.8
BOD_5, LBS.		682	2728.2
AVG. POLLUTANT CONCENTRATIONS			
BEFORE TREATMENT			
SETT. SOLIDS mg/l		1.8	1.8
SUSP. SOLIDS mg/l		21.5	21.5
BOD_5 mg/l		3.2	3.2
AFTER TREATMENT			
SETT. SOLIDS mg/l		0.09	0.09
SUSP. SOLIDS mg/l		2.2	7.5
BOD_5 mg/l		0.5	1.9
TOTAL CAPITAL COST ($)		2,300,000	4,650,000
ANNUAL O&M COST ($)		87,000	275,000
SUSP. SOLIDS + BOD_5			
BEFORE TREATMENT, LBS.		35475	35475
REMOVED, LBS.		31700.2	21922.0
% REMOVED		89.4	61.8
CAPITAL COSTS/% REMOVAL ($)		25,700	75,200
TREATMENT COST (¢/1000 gals)		8.6	21.3

free of floating slicks, scum and odors; and it would support desirable flora and fauna.

Because of its limited nature, this study was not able to delve into the actual physical state of each receiving stream or water body and indicate how effective stormwater management will benefit the stream specifically. However, in an effort to show what results the stormwater management program advanced by this study might attain, a comparative illustration showing the discharges of suspended solids and BOD before and after treatment for the Neponset River Basin are shown in Figures 25 and 26.

TABLE 18

STORMWATER MANAGEMENT

TOTAL COSTS FOR THE STUDY AREA

Total Capital Costs	$465,030,000
Total Annual O&M Costs	$ 55,865,800
Average Treatment Costs (¢/1000 gals)	12.9

Data for the untreated pollutant discharges was obtained from the STORM model output. The pollutant discharges after treatment were calculated after arbitrary judgment was used to select the best stormwater management that was possible by community. This judgment was guided by one primary hypothesis: to furnish the best treatment possible at the lowest possible cost. In many cases, the alternative of choice was No. 2, the use of storage lagoons followed by pumping over 3 to 4 day period to an existing sanitary trunk sewer.

d. Conclusions

In spite of the general nature of this effort, sufficient knowledge has been gained to make conclusions concerning further development for a stormwater management plan for the Eastern Massachusetts Metropolitan Area.

(1) Efforts should be made to calibrate STORM against field data from the Eastern Massachusetts Metropolitan Area to confirm or modify the predicted pollutographs.

(2) Studies should be conducted in various watersheds to determine what variables should be used as input to the STORM model.

FIGURE 25

SUSPENDED SOLIDS DISCHARGE TO NEPONSET RIVER

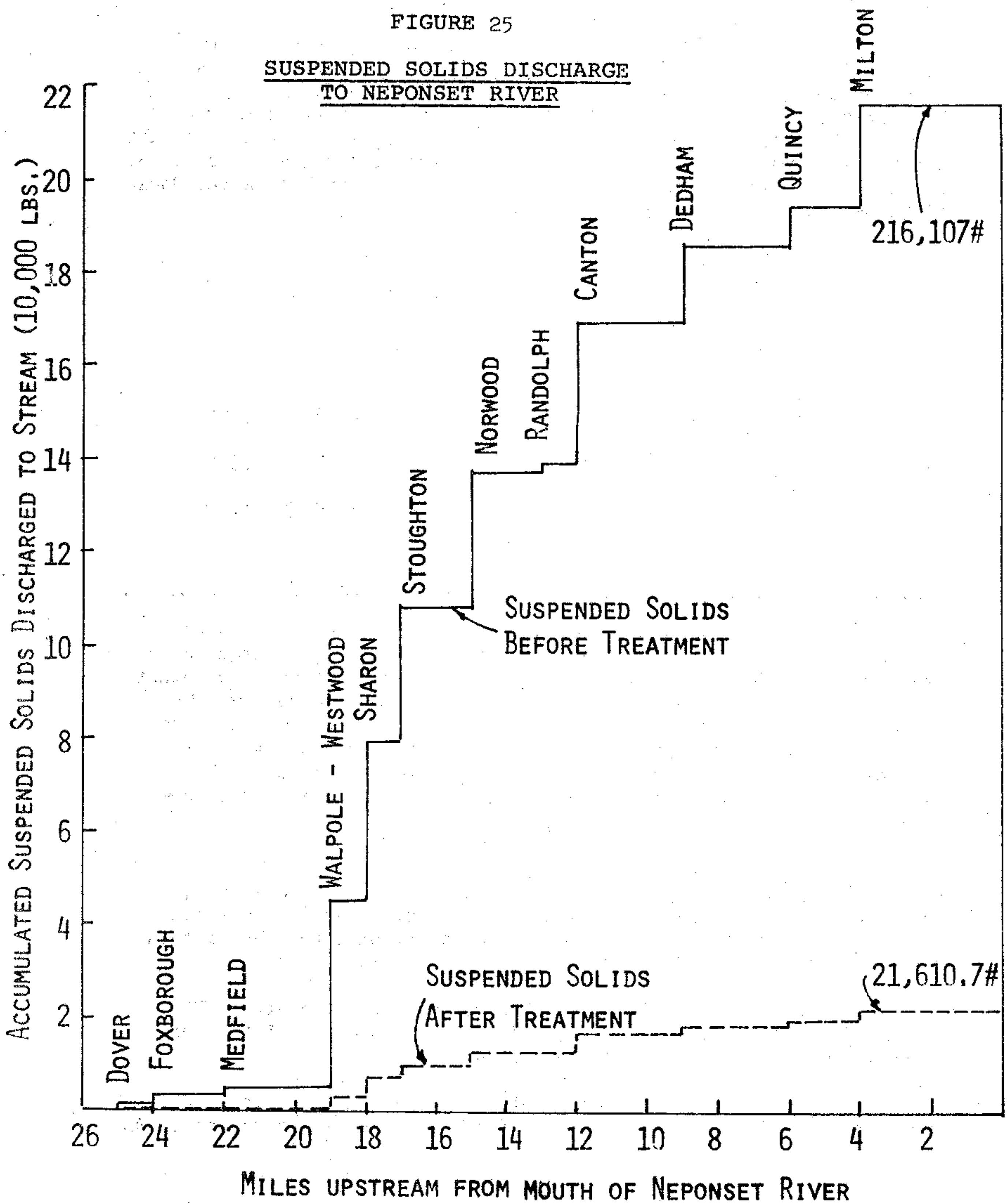
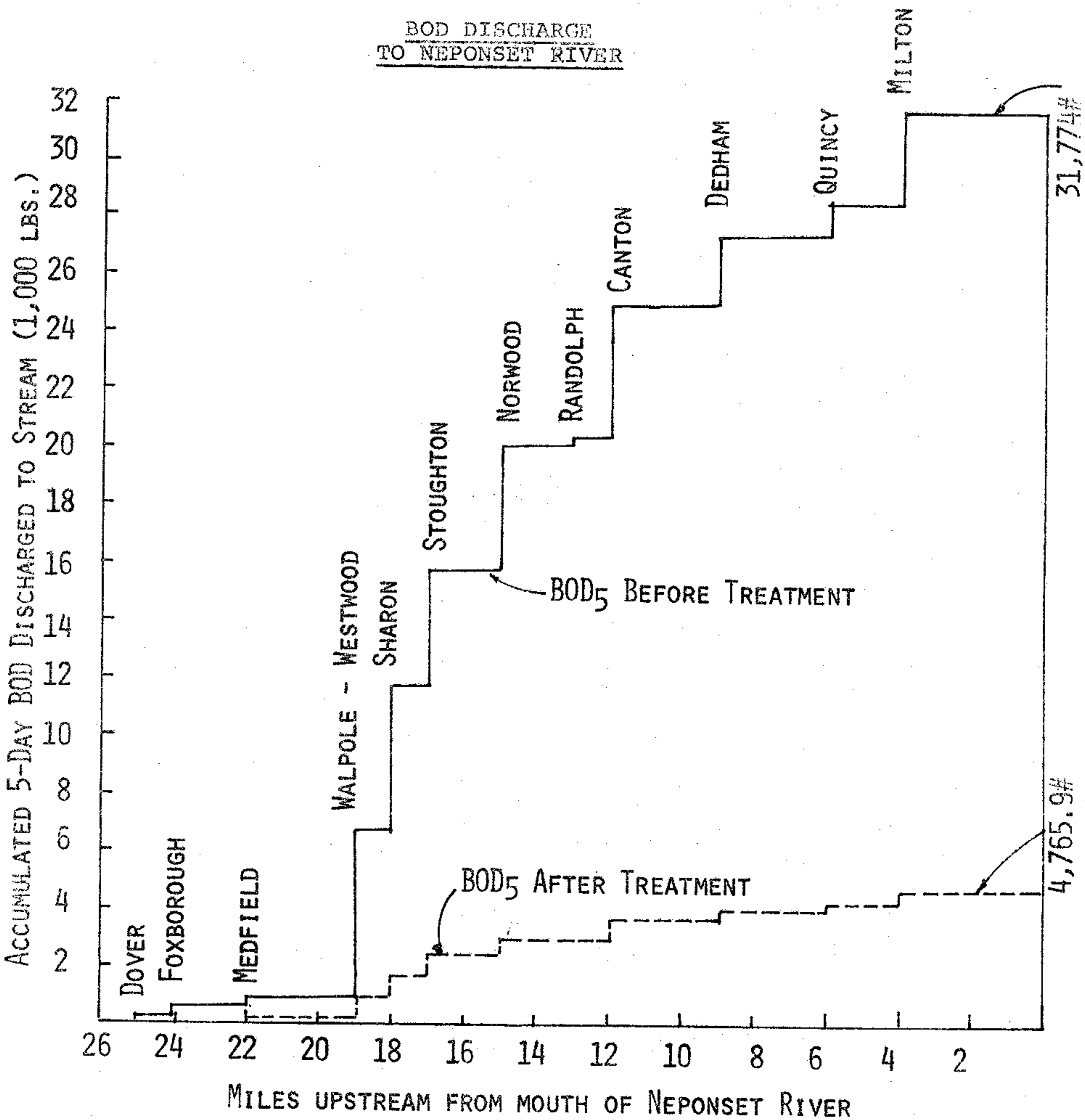


FIGURE 26

BOD DISCHARGE
TO NEPONSET RIVER



(3) The first "flush" theory should be tested by field studies to determine if it actually occurs and under what conditions.

(4) The effects of storage and treatment of stormwater runoff should be carefully studied to determine which conditions limit or optimize this stormwater management method.

(5) The effects of employing storage of stormwater runoff alone with slow release to the receiving stream should be studied in the field.

(6) The effects of stormwater on the water quality in the stream should be studied to determine which are the pollutional parameters of significance.

(7) More study is required to determine how the storage-treatment methodology can be applied to combined sewer overflows.

4. Organizational Alternatives

a. Present Organizational Structure

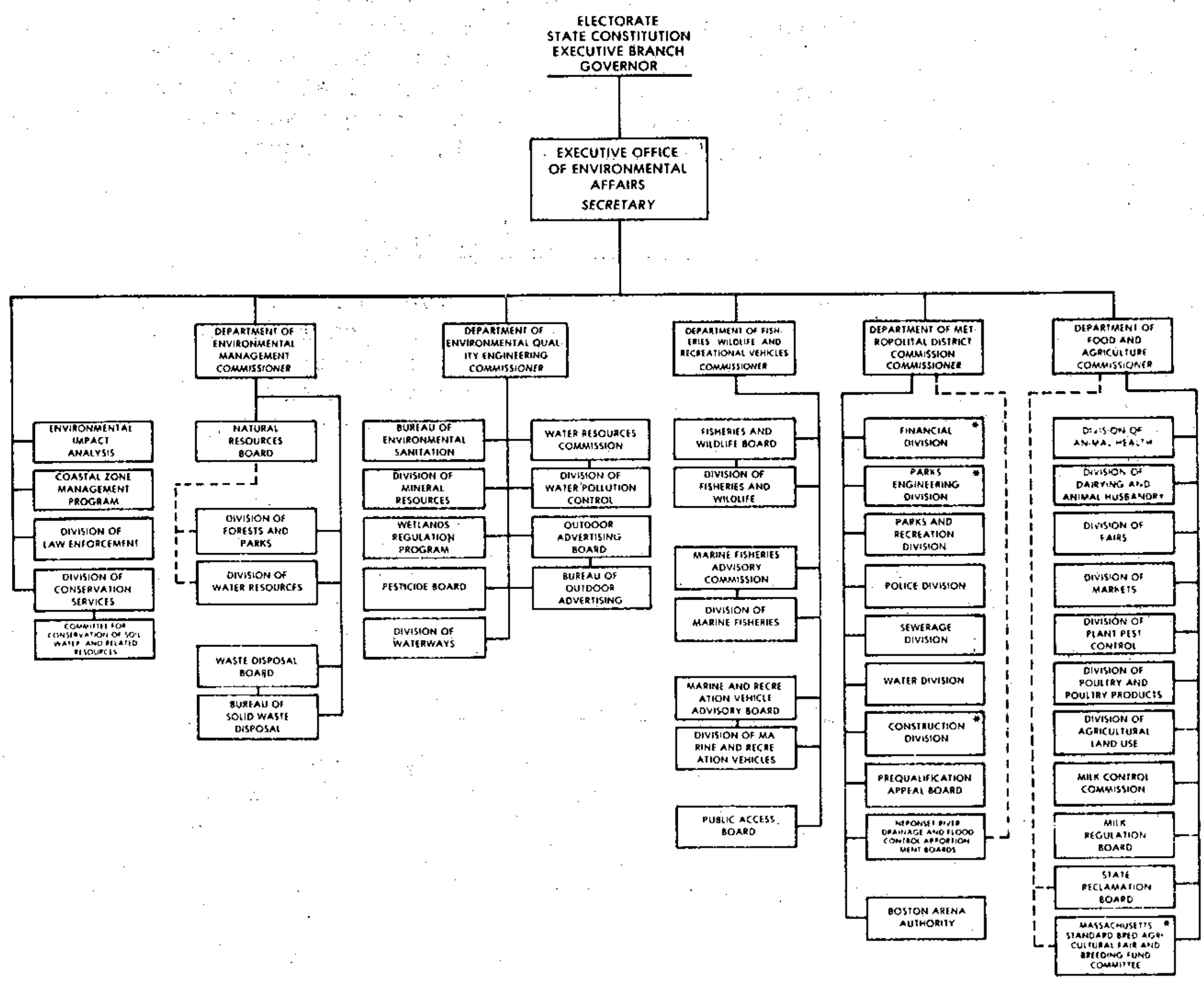
The MDC is a state agency governed by a five member commission (one full-time and four part-time associates) appointed by the Governor. Effective July 1, 1975, it became one of the five operating departments within the Executive Office of Environmental Affairs (EOEA) (see Figure 27). The basic services provided by the MDC relate to water, sewer, parks and police; the first three of which have specified districts.

The MDC's Sewerage Division provides sewage treatment and disposal services from facilities planned, constructed, operated and maintained by the MDC to 43 cities and towns in the Boston Metropolitan area. These 43 communities constitute the Metropolitan Sewerage District (MSD).

The MDC's large construction projects are financed by the sale of bonds. These bonds are sold by the State Treasurer pursuant to an act authorizing such issue and upon request of the Governor. General obligation bonds are backed by the full faith and credit of the state. Since the debt which results from the sale of bonds to finance MDC projects is not incurred for the benefit of the entire commonwealth, it is classified as contingent debt. The interest and principal payments are annually assessed against the member municipalities.

Member municipalities of the MDC are assessed the full cost of service provided within each district. For example, the

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS



ENVIRONMENTAL AFFAIRS FOOTNOTE

(1) Chapter 806 of the Acts of 1974 reorganized the Executive Office of Environmental Affairs to become effective July 1 1975 Since this statutory change was enacted prior to January 1 1975 the Executive Office of Environmental Affairs is shown on this organization chart as reorganized by that statute In certain cases (for example the Pesticide Board currently in the Department of Public Health) entities are being transferred to the new Executive Office of Environmental Affairs and are thereby shown on the chart both where they are now and where they will be effective July 1 1975 (in such cases they are so footnoted)

FIGURE 27

cities and towns within the MDC's Metropolitan Sewerage District pay both the debt service and operation and maintenance costs of wastewater services in addition to local costs of sewage collection. The basis for financing operation and maintenance costs in the MSD is the proportion which each municipality's population bears to the total population of the district. Debt service for the sewerage district is based upon the demand capacity ratio method. A municipality is charged in the ratio of its capacity demand, based on the number and size of its connections, to the capacity available for it in the Metropolitan Trunk Sewer.

b. Proposed Organizational Structures

Five organizational alternatives were designed by consultants to the MDC to provide the management structure necessary to carry out the BH-EMMA recommended plans for wastewater services both efficiently and economically. Each alternative involved some changes in present structure for financing and service delivery. They were as follows:

(1) State Agency
(2) Single-Purpose Regional District
(3) Multi-Purpose Regional Entity
(4) Strengthened MDC
(5) Single-Purpose State Authority

5. Cost Apportionment and Allocation

A financial study was undertaken by consultants to the MDC to (1) develop alternative concepts for dividing costs among municipalities and recommend suitable alternatives, and (2) recommend a suitable method for meeting future capital requirements, considering present Federal and state grant programs and the recommended organizational structure.

a. Approach and Methodology for Dividing Wastewater Treatment Costs and Determining Service Charges

Division of the costs of wastewater treatment services among several participating communities involves the procedures of apportionment, allocation and distribution.

Apportionment is the procedure whereby wastewater treatment costs are divided among various political entities. Costs associated with a facility that benefits a single community are apportioned solely to that community, while costs associated with facilities that benefit several communities are sub-apportioned among those communities.

Allocation is the procedure whereby a community's apportioned and sub-apportioned costs are divided among the various classes of users within that community.

Distribution is the procedure whereby rates are developed for various classes of users within a community and incorporated into a billing system.

Methods for apportioning, allocating and distributing cost are based on an analysis of the use, needs and benefit derived from wastewater treatment facilities and the feasibility of measuring or estimating usage and consumption of wastewater treatment services from users, user classes and municipalities.

b. Current Procedures for Dividing Costs Among Participating Communities

Current procedures for dividing costs among MSD communities are based on two major cost elements: operation and maintenance and debt service costs. Operation and maintenance costs reflect the costs incurred in providing wastewater treatment services on a daily basis, as well as improvement and replacement, engineering and administrative costs. The MSD's debt service costs include the annual amount of principal and interest due on outstanding debt issued to finance the construction of treatment facilities.

Under current procedures, operation and maintenance costs are divided on the basis of a municipality's sewered population. Debt service costs are divided on the basis of the aggregate capacity of a municipality's sewers divided by the total capacity of all municipal sewers.

While existing cost distribution systems are adequate to handle current cost levels (approximately $14 million annually), demands for higher treatment standards will significantly raise cost structures, and may create a need for new cost distribution systems to insure fair and equitable distribution of costs.

c. Federal Grant Requirements

PL 92-500 provides general grants covering as much as 75% of the cost of treatment works, however, grant provisions delineate recipients' responsibilities relating to cost distribution. Provisions that specifically deal with the present method of dividing costs relate to user charges and industrial cost recovery.

User Charges - PL 92-500 states that user charges must include at least the operation and maintenance costs of the service provided, relate to flow, and be proportionate to each user's share.

Industrial Cost Recovery - The grantee must recover from the industrial users of a treatment works the grant amount attributable to the treatment of wastes from such users. Regulations stipulate that industrial cost recovery be based on actual flows as a percentage of design flows.

d. Recommendations for Division of Costs

Recommendations for cost apportionment, allocation and distribution propose increased participation by the MDC in ensuring that wastewater treatment costs are distributed equitably within the service area. Underlying the recommendations is the philosophy that all facilities benefit all users and user classes, and accordingly, all users in the service district should proportionately share the costs incurred in providing services. Major recommendations are summarized below.

(1) Analyze Operation and Maintenance Costs

Since operation and maintenance costs represent the day-to-day costs of providing wastewater treatment services, their analysis will enable MDC to apportion and allocate these costs more accurately and equitably to municipalities and classes of users.

It was recommended that operation and maintenance costs be associated with the elements characteristically found in wastewater (i.e. flow, biochemical oxygen demand and suspended solids) and to facilitate cost analysis and therefore expedite the implementation of user charges that all debt service costs be associated with flow.

Excess capacity should be considered a separate and identifiable cost element although its relevance for the overall system cannot presently be determined. Should any significant level of costs become identified with excess capacity, it may be feasible to apportion this segment of costs to benefiting non-users or future users.

(2) Apportion All Costs Proportionately Among Participating Municipalities and Classes of Users

All existing and planned facilities should be viewed as constituting a single system that benefits all communities. This approach contrasts a concept that divides the service area into several sub-systems and associates facilities with discharges from specific communities or sections of communities.

Important factors considered in the formulation of this recommendation included the number of facilities operated by MDC, number of participating communities, features of the drainage basin, and fundamental principles underlying the creation and evolution of the Metropolitan Sewerage District.

(3) Consider Residential or Population Units for Apportioning Costs Among Communities, Converting Significant Industrial Flows into Equivalent Residential or Population Units

Several alternative methods of measuring or estimating usage for the purpose of apportioning costs were considered. Flow measurement, water consumption statistics, water production and land area were determined to be inappropriate for implementing a cost-efficient, manageable and equitable system for determining usage.

Population and residential units, which can be mathematically converted to sewage flows and characteristics, are readily available from census data. A separate accounting for discharges by large industrial users can be converted to equivalent population or residential units for determining a community's total impact upon a system. Property valuation was recommended as a basis for dividing excess capacity costs.

Separate accounting for industry will provide data upon which user charges and industrial cost recovery charges can be established and forwarded separately to communities for billing purposes.

(4) Institute a System of User Charges and Provide a Detailed Cost Breakdown by User Class to Communities for Their Subsequent Redistribution to Users

In conformance with Federal requirements, the development of a system of user charges was recommended. Significant latitude has been provided for implementing user charges (including metered water consumption of flat rates), and surcharges to large industrial discharges was recommended.

MDC will assist in the development of user charges within communities by providing a breakdown of costs attributed to each user class. Additional technical assistance in establishing charge systems will be provided upon request.

In regard to instituting an industrial cost recovery system, recommendations address the importance of meeting the fundamental provisions and intentions of PL 92-500. It was recommended that the same philosophy upon which costs are apportioned and allocated for the determination of user charges be applied to an industrial cost recovery system. Hence, a system-wide approach (rather than the development of several smaller sub-systems which relate users with specific facilities) was recommended.

Each community will assume responsibility for maintaining an industrial cost recovery system, subject to the MDC's approval. Additionally, the MDC will assist communities in developing the necessary data upon which to determine industrial cost recovery charges and will be available to assist in developing related billing and collection systems.

G. Public Involvement/Open Planning

Preparations for public involvement began immediately after the Commonwealth of Massachusetts and the New England Division, Corps of Engineers signed the agreement to conduct the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study. It was agreed that public involvement in plan development would be sought through an open planning process. The public was considered to be all Federal, state, regional and local agencies and officials, public and private associations and groups, as well as interested individuals and citizens.

In September 1973, the Technical Subcommittee for the study agreed to the formation of a Citizens' Committee. The members of this committee came from academic, commercial, environmental, industrial, legislative and other fields. Its purpose was to help the Technical Subcommittee in its public involvement program and make recommendations on how to improve it. The Citizens' Committee also acted as a sounding board for the engineering concepts developed by the study and for the public presentations of the study.

Five series of public meetings were held during the course of the three year study period for which notices were mailed to approximately 2,500 agencies, organizations and individuals with a known interest in water quality in the metropolitan area.

In November 1973, the Boston Harbor-Eastern Massachusetts Metropolitan Area study held its first series of public meeting. The purpose of these meetings was to provide background information on the study; to explain the public participation program; to present study goals and objectives, and inputs and outputs of the EMPIRIC model used to develop alternative plans for wastewater management; and to explain work being done by the study group to accomplish its goals and objectives.

The public was asked to provide input to all topics discussed at the public meeting. Comments and questions appeared to fall into four major categories:

1. Concern over how study projections and planning assumptions would effect local life styles. Many people expressed a preference for continued reliance on low density development, accompanied by on-site wastewater disposal systems, and favored land use controls over construction of wastewater treatment facilities.

2. Concern over water supply and its relation to wastewater management and disposal.

3. Concern over incorporation of new technologies in the study. Many questions were asked concerning efficiency of secondary and advanced treatment, the feasibility of land treatment, recycling of wastewater and use of alternative sources of energy, such as generation of energy from sludge.

4. Concern over management and funding alternatives and the purpose of the study and its relation to other resource management studies in the area. There was apprehension that the study results would dictate what areas would be sewered, put a moratorium on current plans for new treatment facility construction, and force towns to join the Metropolitan Sewerage District.

In May 1974, the study held a second series of public meetings. At these meetings, the five alternative concepts for wastewater management were presented along with preliminary cost estimates and impact assessments. Major public response fell into the following categories:

1. Concern over the maintenance of river basin integrity and assurance of an adequate supply of water within each basin. Concepts 2 and 4 were favored because of their decentralized approach to wastewater management which returns treated wastewater to its basin of origin.

2. Interest in the feasibility, reliability, health impacts and costs of the land-oriented concept (Concept 5).

3. Again, a preference for low density development accompanied by a continued reliance on individual on-lot disposal systems as an alternative to construction of wastewater facilities in outlying areas.

4. Concern over the costs and management of each alternative and their effects on individual towns and subregions.

5. Minor concern over degree of treatment and effects of treatment facility effluent on water quality.

In summary, the public showed interest in obtaining more information on land treatment and a preference for a decentralized approach to wastewater management. Public preference for decentralization was an important factor in the decision-making process.

In January 1975, a third series of public meetings were held to present the study's recommended wastewater management alternative. These meetings were held in watersheds receiving significant impact from the recommended alternative, and comments at each meeting were directed toward effects of the alternative on the specific watershed.

In Woburn (Mystic River Watershed) citizens were concerned about the effects of added flow under flood conditions and the effect of effluent on water quality. The rationale for 2 mgd facility was questioned, and there were suggestions for flow augmentation by other means. Citizens were also concerned about the division of costs; many felt that towns downstream of the facility should pay, as they would also benefit from improvement in water quality.

In Canton (Neponset River Watershed) citizens were most concerned about the location of the plant. It was felt that Canton could not afford to give up more land. There was also concern over the effects of the effluent on the marshland, fish and water supply wells in Fowl Meadow Marsh.

In Quincy (Boston Harbor) objections were raised to expansion of the Nut Island facility. Citizens commented on the adverse effects of effluent from the currently overloaded Nut Island facility to Quincy Bay. Some supported the idea of upstream treatment plants to reduce the load at Nut Island, while others favored transferring part of the load to Deer Island, or construction of deep ocean outfalls. The need for secondary treatment was also questioned.

In Needham (Charles River Watershed) foremost concern was for the location of the Mid-Charles facility, and for the effects of the facility's effluent on water supply wells, aquatic life and recreation areas. There was also much discussion over recycling and reuse of wastewater and sludges.

Six public meetings were held in May and June 1975 to present institutional-financial alternatives and plans for management of combined sewer overflows.

Again there was great concern over the impacts of proposed treatment facilities in areas that would be served and affected by these facilities.

In Quincy, citizens resisted plans to fill in 26 acres of Quincy Bay to provide for secondary treatment at the present Nut Island facility. They were concerned over the environmental and health effects of the facility, and its discharge, on the beaches and the fishing industry, and the effects of construction activities on the neighborhood surrounding the facility. They asked the MDC to consider one of the harbor islands as a site for construction of a new harbor treatment facility.

In Wellesley, there was much opposition to construction of a satellite advanced treatment facility in the Middle Charles River area. Citizens were concerned over the impact of such a facility on water quality, especially under low flow conditions, and on property values. They requested that citizens be given greater opportunity to participate in formulation of the study's final recommended plan.

Meetings were also held at four other locations in the study area. Citizens attending these meetings were more concerned over the costs of the recommended plan, funding combined sewer overflow control, and the EMMA study's relationship to 208 studies.

A set of final public meetings was held in September and October 1975, to present the study's construction schedule, site selection procedures and the costs of the recommended plan to each community. Again citizens attending meetings in Quincy and Wellesley voiced strong opposition to the construction of a secondary facility at Nut Island, and the proposal for a satellite treatment facility on the Middle Charles River. They were assured that they would have ample opportunity to participate in decisions concerning these facilities and that impacts of these facilities would be further addressed in an Environmental Impact Statement to be prepared by the U.S. Environmental Protection Agency.

In addition to the mentioned public meetings, numerous conferences were held with local municipal officials, news media, and other interested groups, including industry, to obtain further feedback from the public. News clippings, information bulletins, and descriptive printed handout material were distributed to inform the public and seek their comments. The Corps of Engineers received many letters from communities in southeastern Massachusetts opposing the land-oriented alternatives because of the alternative's potential adverse environmental impacts, and its lack of benefits to the recipients' area. This resistance ultimately led, in part, to the study's elimination of a land alternative.

In conclusion, although the wastewater management plan as recommended by the Technical Subcommittee, is technically feasible and is considered to be based on proper engineering judgment, the entire plan was not completely acceptable to all quarters of the public. Many residents and local interests in the Towns of Wellesley, Needham and Dover objected to the proposed 30 MGD regional advanced waste treatment facility for the Mid-Charles River area. Also, the local inhabitants in the vicinity of the existing 112 MGD regional primary treatment facility at Nut Island in Quincy strenuously objected to the expansion of that facility to a secondary treatment plant. Their main concerns were over the malfunctions and maintenance of the existing primary facility at Nut Island, the proposed filling in of twenty-six (26) acres of Quincy Bay adjacent to Nut Island needed for construction of such facility, and possible future raw wastewater overflows and odors from the treatment plant. They voiced the opinion that "upstream" communities, whose wastes are presently being treated at Nut Island and discharged into Quincy Bay, should commence to treat and dispose of their own wastes.

Although some public objections were raised against the proposed 30 MGD regional advanced treatment plant on the Neponset River, the 2 MGD plant on the Aberjona River and the extension of the existing 343 MGD regional primary treatment plant at Deer Island to a secondary treatment facility; these projects appear to have overall public acceptability. The other items of the 52 item construction staging program, such as improvements to overflows, sewer extension, etc., received little comment from the public.

Citizens opposing facilities at Nut Island and in the Middle Charles River area indicated that they would continue to voice their objections during subsequent review periods of the Environmental Impact Statement, which would be prepared by the Environmental Protection Agency prior to the construction of the facilities, and during state legislative meetings and public hearings for discharge permits.

Technical Data Volume 14 of Wastewater Engineering and Management Plan for the Boston Harbor-Eastern Massachusetts Metropolitan Area presents, in detail, the Public Involvement Program for the study.

H. Technical Subcommittee Preferred Plan for Wastewater Management and Recommendations

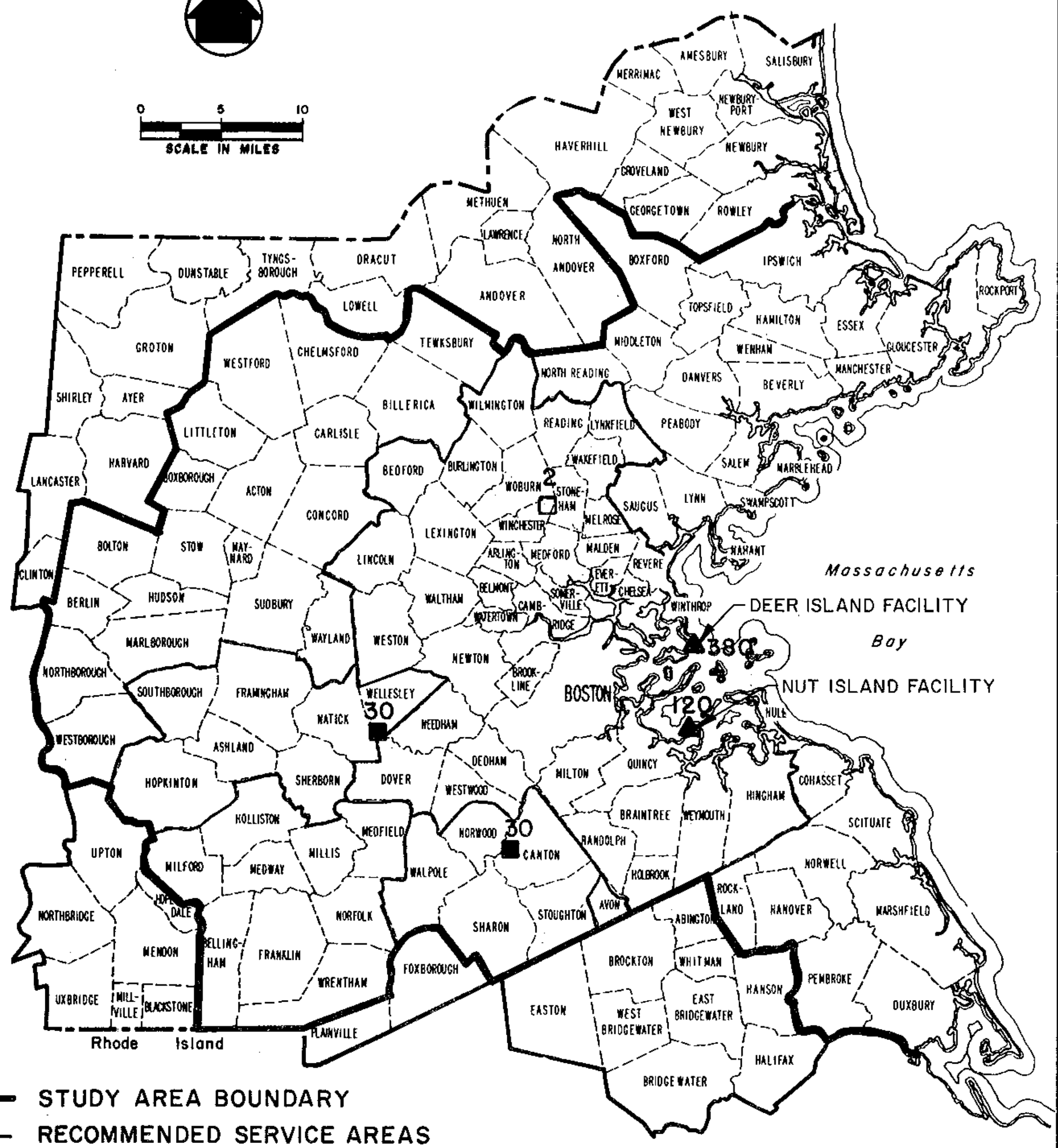
1. Treatment Systems

The Technical Subcommittee has endorsed moderately decentralized treatment systems for the Metropolitan Sewerage District (MSD). This would be done by maintaining the present service area of the Deer Island sewage treatment plant, reducing the service area of the Nut Island sewage treatment plant and serving the outer area of the MSD with inland treatment facilities. The recommended treatment systems encompass 51 study area communities. Treatment systems have been considered for all study area communities. Figure 28 delineates the service areas of the recommended facilities.

The recommendations are based upon providing secondary treatment at the Boston Harbor facilities and advanced treatment which include secondary treatment plus phosphorus removal and complete nitrification at the inland facilities discharging into rivers. Toxic substances in industrial wastes would be subject to EPA pretreatment regulations prior to discharge into sewer systems.

Boston Harbor: The present primary treatment plant at Deer Island would be upgraded to a secondary treatment facility handling anticipated flows of 380 million gallons per day (mgd) in the year 2000. The Nut Island primary treatment plant would also be expanded and upgraded to secondary treatment in order to handle an anticipated flow of 120 mgd in the year 2000. The two plants are currently designed for 343 mgd and 112 mgd. The sludge produced at these facilities would be incinerated rather than discharged into the harbor.

EASTERN MASSACHUSETTS METROPOLITAN AREA WASTEWATER MANAGEMENT STUDY



- STUDY AREA BOUNDARY
- RECOMMENDED SERVICE AREAS

120 APPROXIMATE CAPACITY OF THE FACILITY IN MGD

▲ SECONDARY TREATMENT FACILITY

■ RECOMMENDED ADVANCED TREATMENT FACILITY

□ FLOW AUGMENTATION FACILITY

Figure 28

Neponset River: An advanced treatment facility would be located in the Canton area. It would treat approximately 30 mgd in the year 2000 from the Towns of Canton, Norwood, Walpole, Sharon and Stoughton. This facility would reduce the service area of the Nut Island plant and keep reclaimed wastewater as far upstream in the Neponset River Basin as possible.

Charles River: The middle reach of the Charles River would be the location for an advanced treatment facility to serve the Towns of Wellesley, Framingham, Ashland, Hopkinton, Natick and Southborough as well as parts of Dover and Sherborn when sewerage is provided there. This 30 mgd facility would reduce flows to the Nut Island plant and help retain reclaimed wastewater in its basin or origin. The treatment facilities which are in various stages of implementation in the Medfield, Medway and Milford areas should continue.

2. Organization

A strengthened, more independent Metropolitan District Commission has been recommended by the Technical Subcommittee as the future wastewater management entity for the 51 communities comprising the expanded Metropolitan Sewerage District.

The new management entity responsible for providing wastewater services will carry out the six basic functions (i.e., planning, engineering/construction, financing, operations, monitoring and enforcement) related to sewage collection and disposal. Although institutionally linked to state government and still within the Executive Office of Environmental Affairs, the Metropolitan District Commission (MDC), will be more responsive and accessible to the citizens of the region. This is accomplished by incorporating within the legislation several requirements relative to citizen participation in the policy formulation, planning, program development and project execution phases of the Commission's work.

The primary example of this increased commitment to broader citizen input is the creation of a Municipal Advisory Committee (MAC) composed of municipal chief executives and concerned citizens from within the region. While some "advisory" boards are little more than window-dressing the MAC is given specific statutory responsibility to participate in shaping regional solutions to wastewater management.

The present multi-member Commission structure (one full-time Commissioner and four Associates) would be eliminated in favor of a single Commissioner who, in conjunction with the MAC and supported by Program Directors for each major division, would be responsible for the administration of the new entity. Recognizing the need to provide the MDC with broad authority and freedom from external restraint to ensure progress toward the attainment of Federal standards for waste treatment and water quality, a number of changes are recommended in its legislative base.

These changes, if accepted, will free the MDC from many of the bureaucratic and administrative obstacles associated with state government. Included are recommendations relative to personnel, budgeting, project approval and expenditure control.

The table of organization (Figure 29) reflects the major functions of the MDC and includes a brief list of activities for each function. Particularly noteworthy are the activities under each function which strengthen the relationship between the MDC and the localities served. The MDC will provide assistance to the cities and towns in meeting many of the new Federal requirements under PL 92-500. This broadened technical assistance role will reaffirm the regional character of the MDC and render greater service to the constituent municipalities which pay for one hundred percent of the operating and capital costs of the entity.

3. Combined Sewer Regulation

The three combined sewer regulation alternatives were evaluated for their effects upon the usage of Boston Harbor waters and consultants to the Metropolitan District Commission recommended a course of action to regulate combined sewers in the Boston Harbor area.

The recommended course of action was based on the assumption that treatment will be extended to secondary at the Deer Island and Nut Island treatment plants. Should another alternative involving ocean discharge become the selected plan for these treatment plants, additional opportunities for "combined sewer overflow" regulation may become available. No specific alternative is recommended as more detailed study is necessary in each area.

The following course of action describes outline plans of study for facilities planning projects involving combined sewer overflow regulation.

Dorchester Bay Combined Sewer Overflow Regulation Project. This project would be for a facilities plan on the regulation of overflows in the Dorchester Bay area and should include:

a. Refinement of the combined sewer system models.

b. Rainfall-runoff-overflow measurements in a selected controlled test area for model verification and parameter correlation. These measurements should extend into the receiving water.

c. Detailed consideration of special pollution sources, such as hospitals.

d. Refinement and verification of harbor water quality simulation models for evaluation of potential discharge locations.

RECOMMENDED TABLE OF ORGANIZATION

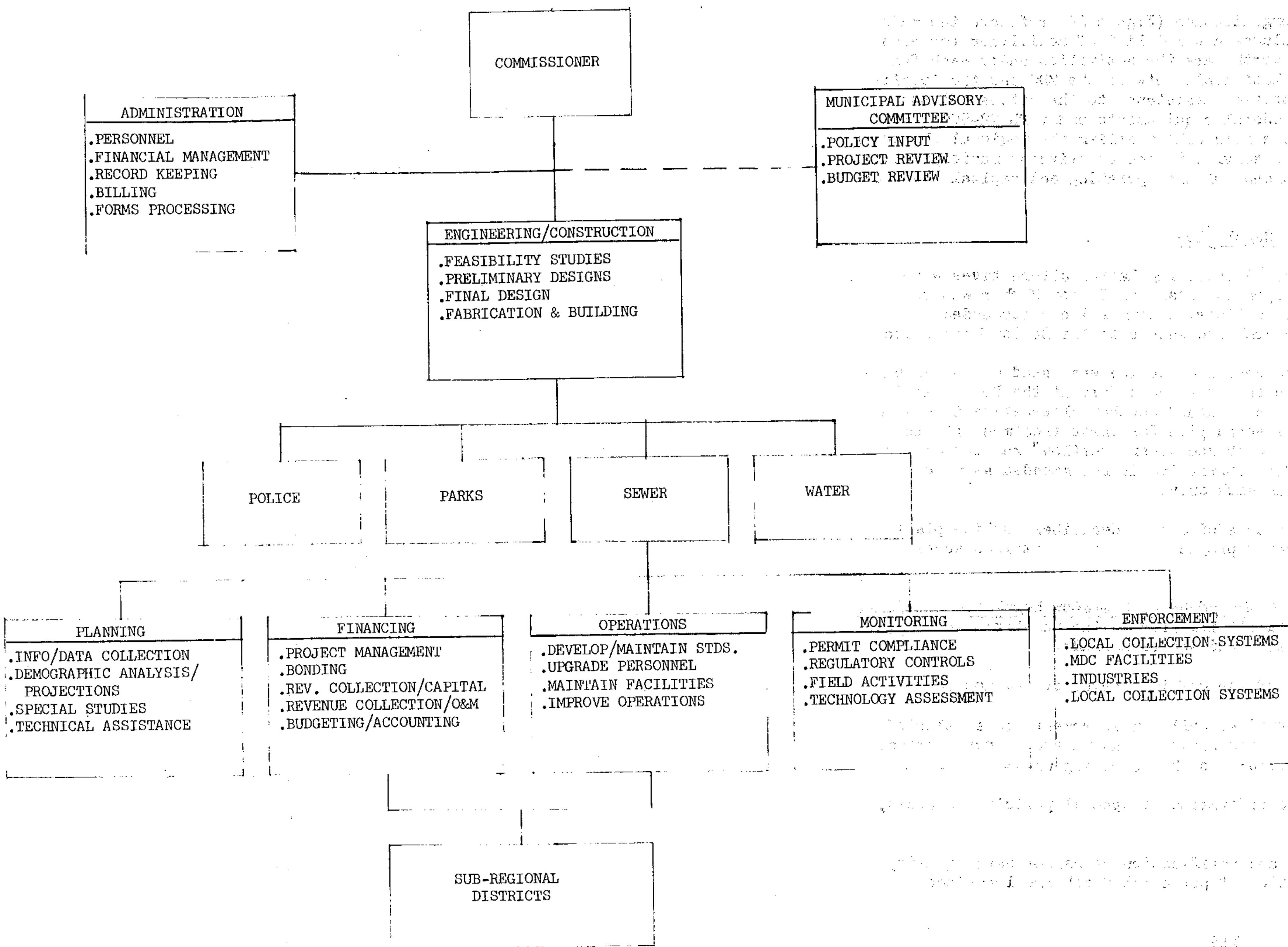


FIGURE 29

e. Evaluation of alternatives. Consideration of diverting discharges in the direction of the Neponset River estuary do not appear desirable. However, alternatives of discharges in the Inner Harbor area and around Moon Island in the direction of President Roads should be investigated. Alternatives should be evaluated on their performance over a longer hydrologic record so that appropriate design hydrology can be used in each case.

f. Detailed inventory and evaluation of the feasibility of upgrading the Moon Island facilities.

g. Site selection and preliminary engineering.

h. Consideration of multipurpose uses of land.

Charles River Basin Combined Sewer Overflow Regulation Project. This project should involve evaluation of the entire system related to combined sewer overflows tributary to the basin once the new dam and related facilities are completed. Included should be the Back Bay Fens area and the as yet unconnected overflows along the Charles River Basin. Facilities planning should emphasize an operating system towards optimum use of existing facilities along with treatment required at new facilities. The major project tasks should be:

a. Refinement of combined sewer models to the extent necessary so that all existing overflow conduits can be evaluated in detail.

b. Rainfall-runoff-overflow measurements in a selected controlled test area for model verification and parameter selection. Since the basin essentially acts as a reservoir, exclusion of pollutants should be the objective rather than searching for an optimum discharge point.

c. Consideration of the state-of-the-art in storage-treatment concepts for overflows discharged above the new Charles River Dam.

d. Consideration of new regulator technologies for upgrading such facilities at the existing overflow conduits.

e. Evaluation of alternatives. Optimum solutions in this project area appear to be an operating system that would make maximum use of existing facilities in such a way that first flush effects are transported to facilities below the dam for treatment and discharge, or are stored and treated more extensively prior to discharge into the basin, or are stored and diverted to the Deer Island treatment plant. Performance of alternatives under longer term hydrologic records must be part of the evaluation. In the development of alternatives, unconnected overflows must be included. Similarly, existing overflow conduits should become part of the operating system.

f. Incorporation of Back Bay Fens recreation objectives in plan selection. In the development of alternatives, the problems and objectives of the Back Bay Fens water resource should be incorporated into the project. For example, solving the Fens circulation problems should be part of the objectives of combined sewer overflow regulation there.

g. Site selection and preliminary engineering.

h. Consideration of multipurpose use of land. In this case, multiuse alternatives would be especially important due to the high recreational potentials in the Back Bay Fens and along the basin.

<u>Neponset River Combined Sewer Overflow Regulation Project.</u> Due to its location, alternatives in this project area would primarily address the search for a cost-effective solution to minimize pollution discharges. The project tasks should include:

a. Refinement of the combined sewer system models.

b. Evaluation of alternatives. Again, performance on the basis of longer range hydrologic data should be evaluated.

c. Site selection and preliminary engineering.

<u>Inner Harbor Combined Sewer Overflow Regulation Project.</u> It appears that consolidation of overflows in the Inner Harbor area will be primarily directed at overcoming constraints associated with space needed for conduits and regulation facilities. Therefore, primary efforts in this area should be directed at the technical problems of conduit location, regulator design and discharge pipe location. The facilities plan should cover among other things the following:

a. Refinement of combined sewer system models.

b. Detailed consideration of industrial pollution sources.

c. Evaluation of consolidation alternatives.

d. Site selection and preliminary engineering.

e. Consideration of multipurpose use of land.

f. Evaluation of overflows in the Constitution Beach area as a special case.

4. <u>Cost Allocation and Financing</u>

The following are the recommendations of the Technical Subcommittee for the allocation of costs within the Metropolitan Sewerage District:

a. Present and future wastewater treatment costs will be shared by all presently connected communities, with all paying at the same rate.

b. Debt service costs incurred for constructing extensions to the present interceptor system for the purpose of connecting newly joining municipalities will be repaid by only those municipalities.

c. Flow, BOD, and SS are the three wastewater characteristics to be considered in municipal cost allocations. Each municipality's share of operations and maintenance costs and debt service costs will be determined as follows:

(1) Contributing population will be served as the principal unit of measure for estimating wastewater and wastewater characteristics discharged by domestic users.

(2) Industrial discharges will be converted to population equivalent units.

(3) Commercial Institutional and other non-domestic discharges will be converted to population equivalent units.

The proporition of a total community's population and population equivalent units to those for all communities will determine its share of costs.

d. Communities will be responsible for distributing allocated costs to various users through user charge systems. MDC will monitor the implementation of user charge systems (assisting in their development whenever requested or required) and assure rightful distribution among user classes. Existing water billing systems will be utilized wherever possible.

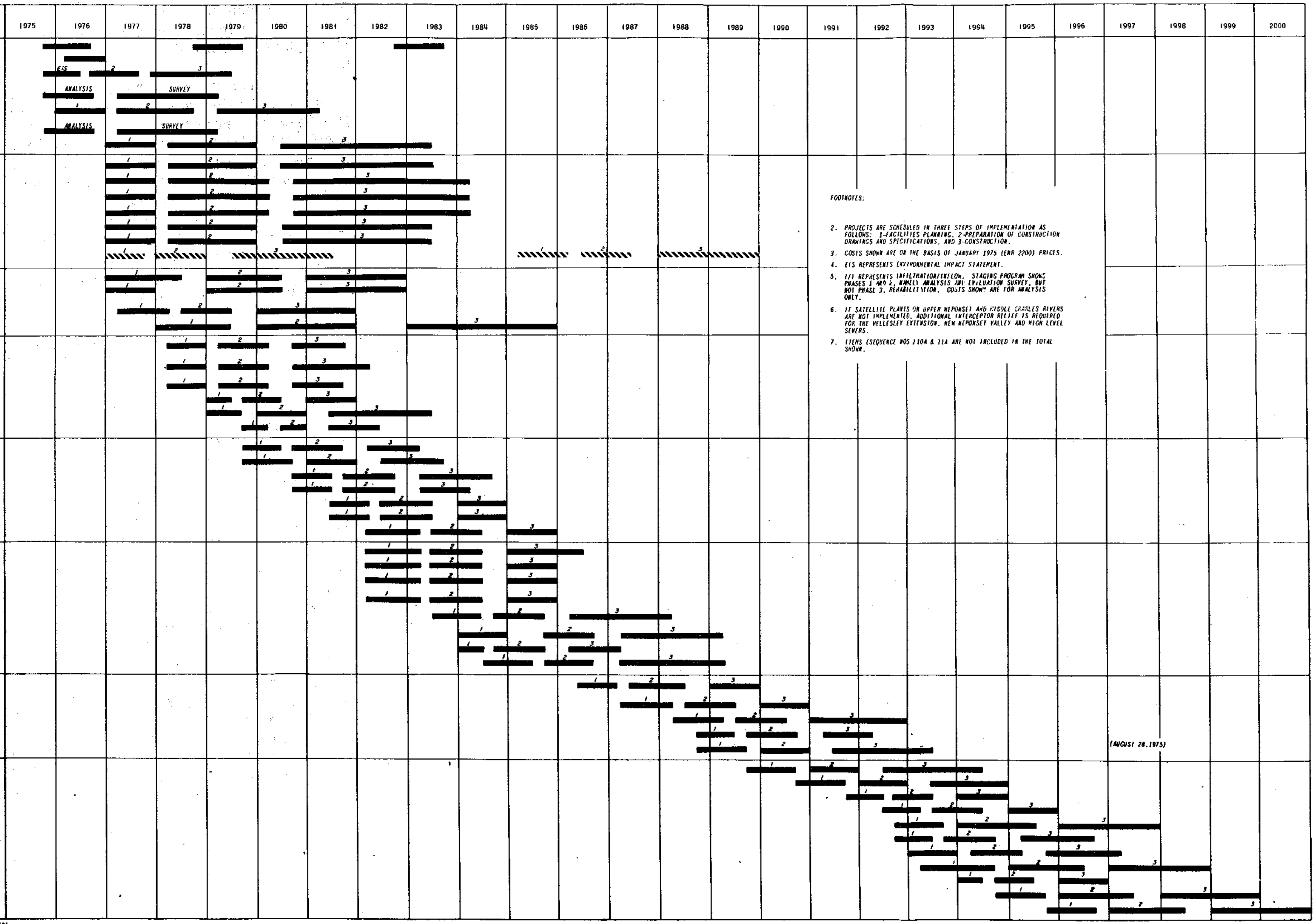
e. Industrial cost recovery (ICR) charges (applicable only to industries subject to ICR regulations) will be allocated on a uniform basis. (See paragraph F.5.c.).

Each community will assume responsibility for distributing ICR charges, with MDC monitoring the individual programs.

5. Figure 30 presents the implementation schedule for the capital improvement projects within the Metropolitan Sewerage District. The schedule of implementation of the financing and organization recommendations is contingent upon the acceptance of the Great and General Court of the Commonwealth of Massachusetts.

MDC CONSTRUCTION STAGING PROGRAM FOR WASTEWATER MANAGEMENT PROJECTS

SEQUENCE NO.	DESCRIPTION(2)	SEWER SECTION NO.	COST $ (3)
	AUTHORIZATION BY LEGISLATURE		
	EIS ON MAJOR STUDY PROJECTS(4)		
1	SLUDGE MANAGEMENT (PRIMARY)		25,573,000
2	I/I ANALYSIS (SOUTH SYSTEM)(5)		983,500
3	DORCHESTER BAY COMB. S. OVERFLOWS		77,000,000
4	I/I ANALYSIS (NORTH SYSTEM)(5)		1,012,000
5	N.I. PRIMARY EXT. (INCL. OUTFALL)		50,536,000
6	D.I. PRIMARY EXP.		41,900,000
7	N.I. SECONDARY EXT.		86,700,000
8	D.I. SECONDARY EXT.		150,000,000
9	SLUDGE MANAGEMENT (SECONDARY)		28,094,000
10	MIDDLE CHARLES R. W.W.T.P.		49,600,000
11	UPPER NEPONSET R. W.W.T.P.		41,100,000
10A & 11A	INTERCEPTOR RELIEF IN LIEU OF (SEQUENCE NOS.) 10 & 11(6)		64,700,000
12	CHARLES R. COMB. S. OVERFLOWS		84,000,000
13	NEPONSET R. COMB. S. OVERFLOWS		23,000,000
14	FRAMINGHAM EXT. S.	134, 133B, 132	22,461,000
15	INNER HARBOR COMB. S. OVERFLOWS		86,000,000
16	LOWER BRAINTREE CONN. S.	125 BRANCH	400,000
17	BRAINTREE WEYMOUTH P.S.		2,920,000
18	HINGHAM F.M.		534,000
19	STOUGHTON EXT. S	119, 121	1,090,000
20	WALPOLE EXT. S.	116, 117, 118	11,894,000
21	NO. CHARLES METRO. S.	63	1,271,000
22	MILLBROOK VALLEY S.	84, 85	3,771,000
23	QUINCY P.S. & F.M.		2,220,000
24	NORTH METRO. S.	17	1,165,000
25	CHELSEA BRANCH S.	57	145,000
26	STONEHAM EXT. S.	51	349,900
27	STONEHAM TRUNK S.	42	145,000
28	EAST BOSTON STEAM P.S.		1,460,000
29	CHARLESTOWN P.S.		6,000,000
30	ALEWIFE BROOK P.S.		712,000
31	EAST BOSTON ELECTRIC P.S.		365,000
32	HOUGHS NECK P.S.		203,000
33	SOMERVILLE MEDFORD BRANCH S.	35	4,500,000
34	SOUTH CHARLES REL. S.	4A, 4H	2,870,000
35	WAKEFIELD BRANCH S.	50-60, 60-49, 59-49	838,000
36	SOUTH CHARLES RIVER S.	5A, 5B	8,428,000
37	CUMMINGSVILLE BRANCH S.	47-85	1,012,000
38	HINGHAM P.S.		890,000
39	REVERE EXT. S.	87A, 62	3,413,000
40	LYNNFIELD EXT. S.		987,000
41	ASHLAND-HOPKINTON EXT. S.		4,459,000
42	WESTON-LINCOLN EXT. S.		3,832,000
43	SOUTHBORO EXT. S.		2,421,000
44	SHARON EXT. S.		1,218,000
45	STOUGHTON EXT. S.	119, 120, 121	827,000
46	WILMINGTON EXT. S.	89, 90	2,964,000
47	NORTH METRO S.	44.5, 87, 112	476,000
48	WESTWOOD EXT. S.	195, 196	2,350,000
49	WAKEFIELD TRUNK S.	58-41, 58-41, 87, 40	4,764,000
50	WAKEFIELD BRANCH S.	50-60	177,000
51	SO. CHARLES RELIEF S.	4H, 4G, 4F, 5E, 5F	8,911,000
52	SO. CHARLES RIVER S.	5C	4,250,000
	TOTAL		865,359,000(7)



FOOTNOTES:

2. PROJECTS ARE SCHEDULED IN THREE STEPS OF IMPLEMENTATION AS FOLLOWS: 1-FACILITIES PLANNING, 2-PREPARATION OF CONSTRUCTION DRAWINGS AND SPECIFICATIONS, AND 3-CONSTRUCTION.
3. COSTS SHOWN ARE ON THE BASIS OF JANUARY 1975 (ENR 2200) PRICES.
4. EIS REPRESENTS ENVIRONMENTAL IMPACT STATEMENT.
5. I/I REPRESENTS INFILTRATION/INFLOW. STAGING PROGRAM SHOWS PHASES 1 AND 2, NAMELY ANALYSIS AND EVALUATION SURVEY, BUT NOT PHASE 3, REHABILITATION. COSTS SHOWN ARE FOR ANALYSIS ONLY.
6. IF SATELLITE PLANTS ON UPPER NEPONSET AND MIDDLE CHARLES RIVERS ARE NOT IMPLEMENTED, ADDITIONAL INTERCEPTOR RELIEF IS REQUIRED FOR THE WELLESLEY EXTENSION, NEW NEPONSET VALLEY AND HIGH LEVEL SEWERS.
7. ITEMS (SEQUENCE NOS.) 10A & 11A ARE NOT INCLUDED IN THE TOTAL SHOWN.

Figure 30

I. Discussion

Most studies commenced before enactment of PL 92-500 and all were carried out while the guidelines for the law were being prepared and reviewed by the U.S. Environmental Protection Agency. This precluded all of the studies from being carried out on an identical basis, and different assumptions and interpretations were made by each study team. These differences continued although agency coordination was exercised throughout the study periods.

All study efforts carried out public participation programs with varying degrees of success. The BH-EMMA and Merrimack studies utilized the report titled "Open Planning/The Merrimack" prepared for the Corps of Engineers by the New England Natural Resources Center as a guide for carrying out the public participation program. Throughout each open planning program, Informational Bulletins were prepared and distributed and Public Meetings, Workshops and discussions with both public officials and private citizens were held.

Although the studies did not make the same cost assumptions, the following table briefly summarizes some of the important facts derived from each study.

SUMMARY OF PROGRAM DATA (1)

Program	Population in Study Area	Population Sewered	Estimated Wastewater Flows (MGD)	Est. Cost of Program
Merrimack Wastewater Management Study	650,800	374,900	122.30	$722,020,000 (2)
New Hampshire Plan	1,116,500 (3)	389,510	59.24 (4)	167,640,000 (5)
Nashua River Program	249,818	165,338	46.65	67,776,000 (6)
BH-EMMA Study	3,566,000	3,030,000	560.00 (7)	855,359,000 (2)

(1) Based on 1990 requirements except as noted.
(2) Based on ENR = 2200 Index.
(3) Includes seasonal population of approximately 390,000 persons.
(4) Flows for 1977.
(5) Based on 1973 prices.
(6) Excludes the estimated cost of $17,000,000 for the Nashua, N.H. treatment plant. The estimated cost of the Nashua facility is included in the $167,640,000 for the New Hampshire Plan. Based on 1975 prices.
(7) Flows for 2000.

The Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study (BH-EMMA) initially encompassed 109 cities and towns within a 30-mile radius of the City of Boston. More than 3,000,000 people or better than half of the state population live within these 109 communities. Forty-three of the 109 communities are members of the Metropolitan Sewerage District (MSD) which is administered by the Metropolitan District Commission for the purposes of commonly collecting and treating their wastewaters. Each municipality within the MSD is responsible for maintenance and operation of its own sewerage system prior to discharging into the MSD trunk sewers. Each community is also subject to the rules and regulations set forth by the Metropolitan District Commission. The MSD system consists of more than 200 miles of main trunk sewers and presently serves approximately 2 million people. Except for wastewater discharged through combined sewer overflows and/or discharged to surface waters, the wastewater from the MSD flows to either the Deer Island or Nut Island treatment plants, where it receives primary treatment and chlorination before it is discharged into Boston Harbor. These systems are now operating at full capacity. The major waterways that were directly affected by the planning effort in addition to Boston Harbor are as follows:

Charles River
Sudbury, Assabet & Concord Rivers (SUASCO)
Ipswich River
Mystic River
Neponset River

For years Boston Harbor has been the ultimate recipient of wastewater, domestic and industrial, stormwater runoff and combined sewers overflow, emanating from the greater portion of the study area. Over the years, this situation has caused serious degradation to the water quality of the harbor. In the past, numerous Federal, state and local agencies as well as private conservation groups, organizations and individuals have made many attempts to clean up the harbor and promote programs for greater public use. In fact, many of the harbor's thirty-three islands have been acquired by the Commonwealth of Massachusetts, with Federal assistance, for recreational development. The success of this recreational development depends on quality of the harbor waters. Concern over water quality of Boston Harbor was the principal reason for the May 1972 agreement between the Metropolitan District Commission of the Commonwealth of Massachusetts and the U.S. Environmental Protection Agency to undertake a comprehensive engineering and management study with the following objectives: to determine most feasible means of achieving a minimum of secondary treatment at all wastewater treatment facilities in the Boston Metropolitan region; to determine engineering alternatives for handling sludges generated by MDC treatment facilities; and to develop a management program taking into consideration changes in management structure, rate structure, user charges and methods of capital financing. More detailed information on the EPA-State agreement and implementation plan can be found in Chapter VII of this report.

The Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study (BH-EMMA) recognized the goals and objectives of PL 92-500 principally through addressing the requirements of Section 201 of the Act. The results of the study constitute a facility plan for the Boston Metropolitan area, which will be included in the area's 208 planning process.

In June 1972, a Congressional Resolution was issued authorizing the Secretary of the Army, through the Corps of Engineers, to undertake a wastewater management study in the Boston Metropolitan area. This study was to be conducted jointly with the Commonwealth of Massachusetts. In August 1972, the Commonwealth and the Corps representatives conferred and decided that, to avoid duplication of efforts, the Corps and MDC would prepare a joint Plan of Study and conduct the study as a single joint effort.

The BH-EMMA study was a joint effort in funding as well as in performance of the technical tasks shown in Figure 9 of this report. The Corps of Engineers contributed approximately 50 percent of the study effort and the Metropolitan District Commission (MDC) contributed about 50 percent of the total program cost of about $2,200,000. The technical tasks for the study were performed by private consultants, miscellaneous state and local agencies and the staffs of the Corps and MDC. Since the Corps was chairing the "Merrimack" study, it was agreed that the Metropolitan District Commission should chair the BH-EMMA study. Since the Metropolitan District Commission, in compliance with its May 1972 agreement with the U.S. Environmental Protection Agency, had already begun negotiations with private consulting firms in the Commonwealth of Massachusetts-EPA agreement before the Corps of Engineers' efforts should supplement those items which the Metropolitan District Commission was to accomplish. The items that were addressed by the Metropolitan District Commission are:

a. Development of the basic data for the study area.

b. Establishment of limits and wastewater systems for the Eastern Massachusetts Metropolitan Area.

c. Preparation of preliminary engineering plans for additional treatment of Deer and Nut Islands' flows.

d. Operation and regulation of sewage interceptors and overflows.

e. Industrial waste ordinance.

f. Management study.

g. Progress and final report of conclusions.

The Corps of Engineers' input to the study effort was designed to both supplement those items being addressed by the Metropolitan District.

Commission and to satisfy Congressional directives. The major items addressed by the Corps are:

a. Public participation and information program.

b. Land treatment alternatives.

c. Industrial waste survey.

d. Impact analysis and evaluation.

e. Stormwater and urban runoff.

An open planning and public participation program was conducted throughout the entire BH-EMMA study period. Approximately 120 conferences and public meetings were held during the course of the study. At the end of the study period, approximately 3,000 persons, organizations and agencies were on the BH-EMMA mailing list. Five sets of public meetings were held at different locations throughout the study area. The initial low attendance at most public meetings was disappointing. As the study progressed, attendance greatly improved in localities where there were strong objections to proposed study elements such as the expansion of Nut Island in Quincy Bay to accommodate a secondary treatment facility, and the siting of a 30 MGD satellite advanced wastewater treatment facility in the Mid-Charles River Basin area. A Citizens' Advisory Committee was formed to assist the Technical Subcommittee in the Public Participation Program. This Citizens' Committee contributed greatly to the program, offering critiques as the study progressed, and furnishing valuable recommendations; one such was to hold separate meetings for local officials to brief them on the study prior to general public meetings. There were mixed conclusions as to the accomplishments of the open planning program.

With respect to industrial wastewater treatment, it was assumed that the pretreatment requirements for industry will be strictly enforced under regulations set up in compliance with PL 92-500.

In July 1975, the Environmental Protection Agency furnished the Metropolitan Area Planning Council (MAPC) with a grant of $2,300,000 to accomplish an "Areawide Waste Treatment Management" study under the provisions of Section 208 of PL 92-500 for 92 communities in the Boston area. These 92 communities are included in the original group of 109 cities and towns initially investigated by the BH-EMMA study. It was mutually agreed by the U.S. Environmental Protection Agency, the Metropolitan District Commission and the Metropolitan Area Planning Council that the BH-EMMA study results would be incorporated into the "208" plan.

The 51 communities designated in the wastewater management plan recommended by the Technical Subcommittee for BH-EMMA study include 43 communities which are presently members of the Metropolitan Sewerage

District (MSD). The study recommends that eight other communities be joined to the existing MSD study. The remaining towns of those originally considered which were not incorporated into the preferred plan are in various stages of wastewater management planning and their status can be reviewed in Technical Data Volume 13, Impact Analysis and Evaluation. The majority of these 58 communities are on EPA-State Implementation Programs or have existing treatment facilities. Some are served by on-lot individual disposal systems such as septic tanks with leaching fields. Where on-lot systems are desired to be retained, strong regulatory enforcement measures and land use controls will have to be maintained.

Technical Alternative (Concept) No. 5 had a combination of both land and water-oriented wastewater treatment systems. The land treatment portion of the concept was developed to treat approximately 177 MGD of wastewater flow. This system excluded an estimated wastewater flow of 289 MGD which is subject to saltwater infiltration due to faulty collection systems. Since there is insufficient land area (except for 190 acres) suitable for land treatment within the initial 109 cities/towns in the study region, it was proposed to pipe and pump the 177 MGD to southeastern Massachusetts, where sufficient and suitable land areas exist. Approximately 18,700 acres are required for land application of the 177 MGD utilizing both spray irrigation and rapid infiltration treatment techniques. The overland flow method of treating wastewater was considered but was found infeasible in this region. Wastewater storage lagoons required in connection with the spray irrigation method were designed for 14 days of storage and those required for rapid infiltration were designed for 14 days of storage. Although adverse public reaction from the officials and residents of the recipient area was strong and ultimately became part of the reason for not choosing the land application concept; it must be noted that some of the towns in the recipient region presently utilize and/or plan to use land application treatment of wastewaters. The publics of the recipient areas seemed to object more to the transmission of wastewaters from the Boston Metropolitan area to their localities for application than they did with the land application technique itself. Many individuals and towns desired information on land application for their own use in planning for future local wastewater treatment needs. Detailed information on the Land Concept can be found in Technical Data Volume 5 of The Wastewater Engineering and Management Plan for the BH-EMMA.

At a seven acre site on Otis Air Force Base, Cape Cod, Massachusetts, which was part of the proposed recipient area, the Commonwealth of Massachusetts, under a grant from the U.S. Environmental Protection Agency, is conducting a three (3) year test and evaluation of spray irrigation method using secondary treated wastewaters. The study is scheduled to be completed in 1977 and the results will determine whether or not the Commonwealth of Massachusetts will favor this method of treatment in Massachusetts. This study was an outgrowth of public objections in the Town of Falmouth, Massachusetts to the discharge of wastewater from their proposed secondary treatment facility into their local harbor.

If the Otis tests prove acceptable, there is little doubt that the Town of Falmouth will use spray irrigation as a means of further treatment and disposal of their wastewaters.

With respect to land application of wastewaters, suitable conditions were also found in the Merrimack River Basin. The Corps, Commonwealth of Massachusetts, and the State of New Hampshire reports propose land application facilities in their preferred wastewater management plans.

J. The Boston Harbor-Eastern Massachusetts Metropolitan Area Study's Response to Planning Goals and Objectives

National Goals as Established in PL 92-500	Response
(1) "The discharge of pollutants into navigable waters be eliminated by 1985."	The Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study has not investigated the full implications of this goal. The land alternative, developed by the Corps of Engineers does address this goal, and all study alternatives recognize compliance with Section 201 of the Act as a step towards the achievement of this goal.
(2) "Wherever attainable, an interim goal of water quality which provides for protection and propogation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."	The recommended construction program of facilities in the Eastern Massachusetts Metropolitan Area was formulated to address the water quality and waste treatment needs of the region. The Recommended Plan should provide water quality which will provide for protection and propogation of fish, shellfish and wildlife and provide for recreation in and on the water through its compliance with Section 201 of the Act. The study's recommended construction program proposes that the study area's water quality and waste treatment needs be met by 1983. Management of combined sewer overflows and treatment facility sludge and correction of infiltration inflow problems are given equal priority with initiation of secondary treatment at the two Boston Harbor treatment facilities, as it was a study finding that correction of combined sewer, storm water and sludge pollution will have a greater beneficial impact on the water quality of the harbor than the implementation of secondary treatment.

Requirements of Section 201 of PL 92-500	Response
(1) "Waste treatment management plans and practices shall provide for the application of the best practicable waste treatment technology before any discharge into receiving waters, including reclaiming and recycling of water...and shall provide for consideration of advanced waste treatment techniques."	Treatment facilities proposed in all the alternatives and the Recommended Plan for the Eastern Massachusetts Metropolitan Area were formulated to provide a minimum of best practicable waste treatment as defined by the U.S. Environmental Protection Agency. In addition all facilities proposed to discharge to fresh water were formulated to provide advanced waste treatment through addition of phosphorus removal and nitrification to secondary treatment. The Recommended Plan proposes two major advanced waste treatment facilities which will recycle water to the Charles and Neponset Rivers.
(2) "To the extend practicable, waste treatment management shall be on an areawide basis."	All plans were formulated on an areawide basis. The Recommended Plan increases the Metropolitan Sewerage District from its current 43 members to 51, and contains 4 "regional" treatment facilities.
(3) "Encourage waste treatment management which results in the construction of revenue producing facilities providing for the recycling of potential sewage pollutants through the production of agriculture, silvaculture, or aquaculture products, or any combination thereof."	The land-oriented concept, Concept 5, provided for the treatment of 187 MGD of sewage from the Eastern Massachusetts Metropolitan Area by land application in Southeastern Massachusetts. Part of this land system would have provided for production of agriculture and/or silvaculture products.
(4) "Encourage waste treatment management which results in integrating facilities for sewage treatment and recycling with facilities to treat, dispose of, or utilize other industrial and municipal wastes, including but not limited to solid waste and waste heat and thermal discharges..."	The opportunity exists to integrate the disposal of municipal and industrial solid waste with the treatment and disposal of sludge from the satellite facilities. Such opportunities will be considered by the Metropolitan District Commission before grant application for satellite facilities.

Requirements of Section 201 of PL 92-500 (Cont'd)	Response
(5) "Encourage waste treatment management which combines "open space" and recreational considerations with such management."	The land application portions of Concept 5 would have acted to preserve "open space" upon implementation. It was envisioned that recreation could have been integrated with the land treatment system. Both the Recommended Plan and the construction program recognize the importance of recreation through proposals to (1) return treated wastewater to the Charles and Neponset Rivers, thus alleviating unpleasant low flow conditions in these rivers, and (2) to control combined sewer overflow and eliminate sludge disposal to recreational waters of Boston Harbor.
Specific Study Objectives	
(1) To develop recommendations for the management of wastewater in Eastern Massachusetts up to the year 2050.	Four water-oriented and one land-oriented wastewater management alternatives were developed for the Boston Harbor-Eastern Massachusetts Metropolitan Area Study Area (Technical Data Volumes 4 and 5). Plans for Management of Combined Sewer Overflows (Volume 7), Stormwater (Volume 8) and Financing and Management (Volume 12) were also developed.
(2) To determine the ultimate growth or contraction of the Metropolitan Sewerage District (MSD) to the year 2050. All engineering, economic, and environmental aspects to be considered, including the river basin concept.	Engineering alternatives ranged from a highly centralized system with maximum expansion of the current Deer and Nut Island treatment facilities to serve 58 communities to a decentralized system with contraction of the current Deer and Nut Island facilities service area and establishment of 6 satellite regional systems on river's tributary to Boston Harbor. Biological, aesthetic, hygienic and socio-economic impacts of these alternatives are presented in Technical Data Volume 13.
(3) To make recommendations for a management organization for the MSD and its subregional districts as may be projected. Administrative structure, policies, financial arrangements, and related management matters to be considered.	Recommendations for management organization are presented in Financing and Management, Technical Data Volume 12.

Specific Study Objectives (Cont'd)	Response
(4) To determine facilities required for the collection, treatment and disposal of existing and future MSD sewage flows including the preparation of preliminary engineering designs for the recommended method of treatment for the Deer Island and Nut Island projected sewage flows.	Analyses and recommended improvements of Deer and Nut Island treatment facilities are presented in Technical Data Volumes 10 and 11.
(5) To make recommendations for the regulation of combined sewage overflows, infiltration, and stormwater with respect to both the MSD system and the systems of its member communities.	Recommendations for regulation of combined sewage overflow, stormwater and infiltration are presented in Technical Data Volumes 7, 8 and 9.
(6) To undertake an industrial waste survey and inventory including developing industrial waste regulations and an equitable cost recovery system.	An industrial waste survey of 5 categories of industries within the study area was completed and a sewer use ordinance and equitable cost recovery system was developed from this information. (See Technical Data Volumes 3 and 12, respectively).
(7) To determine the feasibility of reclamation and reuse of wastewater and treated water.	Reclamation and reuse of wastewater was considered both in Concept 5, the land-oriented concept, and in water-oriented satellite concepts, where treated wastewater would be returned to local surface waters.
(8) To develop short-range construction programs and detailed plans for facilities required by the year 2000.	Construction programs and detailed plans for facilities recommended by the study are presented in Recommended Plan and Implementation Program, Technical Data Volume 15.
(9) To develop a public participation program throughout the duration of the study.	The study's public participation program is discussed in Technical Data Volume 14. Approximately 120 conferences, presentations and public meetings were conducted during the study period.
(10) To meet the requirements of Section 201 of Public Law 92-500.	See discussion of National Goals.

K. Summary and Findings

The wastewater management study for the Boston Metropolitan area was initiated prior to the enactment of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). However, as the study progressed, a number of the provisions of the Act were addressed especially in the area of facilities planning.

The Technical Subcommittee considered background data on 109 communities in order to determine that the primary study area should consist of those communities which could logically and feasibly be formed into a "preferred" single wastewater management system. On this basis, 51 communities were selected for detailed examination. It was found that the other communities should continue with their present wastewater management programs and integrate them with future "208" areawide planning efforts.

Four water-oriented treatment alternatives and one combination water/land oriented treatment alternative were developed during the study. Pertinent socio-economic, institutional-financial, biological, aesthetic and public health impacts were assessed, and one water-oriented system was selected by the Technical Subcommittee as a preferred plan. This plan consists of a moderately decentralized treatment system for the MSD designed to meet the 1983 requirements of PL 92-500. This would be accomplished by upgrading the harbor treatment facilities to secondary treatment, maintaining the present service area of the Deer Island sewage treatment plant, reducing the service area of the Nut Island sewage treatment plant and serving the outer area of the MSD with inland advanced treatment facilities on the Charles and Neponset Rivers.

It was found that:

1. The four water-oriented and one land-oriented wastewater management alternatives would meet at a minimum the 1977 and 1983 goals of PL 92-500. In addition the land oriented facilities would address the 1985 goal.

2. All water-oriented concepts should be formulated around the existing network of facilities, since rearrangement of the existing network would be far too costly and disruptive.

3. The present Metropolitan Sewer District (MSD) consisting of 43 cities and towns should be expanded to include the 51 communities shown in the preferred plan.

4. The "preferred plan" will be accepted by the 208 areawide planning agency thereby allowing remaining planning to concentrate on other cities and towns.

5. The preferred plan and all improvements will cost about $850 million.

6. Additional information should be developed on stormwater runoff, storage and treatment. A field sampling program should be undertaken to accurately determine the quality and quantity of stormwater runoff. Priority for such a program should be given to the Charles, Neponset, and Mystic River Basins.

7. An equitable system for recovery of industrial wastewater treatment costs can be considered as a result of the Corps of Engineers inventory of 925 industries.

8. All present and future treatment costs should be shared with all connected communities paying at equal rates based on waste loadings i.e. wastewater flow, biochemical oxygen demand (BOD), and suspended solids (SS).

9. A "Strengthened Modified Metropolitan District Commission" would be the preferred organization to expedite implementation of the constrcution program and comply with agreements between the Commonwealth of Massachusetts and the U.S. Environmental Protection Agency. This agency should be responsible for planning, engineering/construction, financing, operations, monitoring and enforcement related to sewage collection and disposal.

10. Further design phases of the Middle Charles and Upper Neponset satellite treatment facilities, should include study of optimum outfall locations and potential effects on water supply wells adjacent to the rivers and downstream of outfalls.

11. Detailed circulation studies, coupled with chemical tracking, should be undertaken in Boston Harbor as well as studies on the aorption and desorption of metals from the bottom materials of the harbor.

IX. VIEWS AND RECOMMENDATIONS OF THE REPORTING OFFICER

1. It is the view of the Reporting Officer that:

a. This Report presents, summarizes and completes the wastewater management planning efforts in the study area by the Corps of Engineers as requested in the applicable Congressional Resolutions which authorized the studies.

b. Wastewater management planning efforts described in the foregoing discussion have made a significant contribution toward improvement of water quality in the Merrimack River Basin and the Boston Metropolitan area.

c. The cooperative efforts of several resource agencies working together produces meaningful and viable plans.

d. The existing wastewater management system in the Boston Metropolitan area limited the number of viable alternatives that could be arrayed.

e. The "preferred plan" of the Technical Subcommittee on BH-EMMA study, while not totally socially acceptable in the vicinity of the Nut Island treatment plant and the proposed Mid-Charles satellite facility, is technically feasible and engineeringly sound. Further consideration in the future will be given the plan by local decision makers before the plan is implemented.

2. The Reporting Officer recommends that:

a. The results reported in this report be utilized by Federal, state, regional and local entities as a basis for further planning and development of wastewater management under Sections 201, 208 and 303 of PL 92-500.

b. This report and its supporting documents be transmitted to the Congress for its information.

JOHN H. MASON
Colonel, Corps of Engineers
Division Engineer

NADDE (Dec 75) 1st Ind
SUBJECT: NEWS Study Report on Wastewater Management Merrimack River Basin - Boston Metropolitan Area

DA, North Atlantic Division, Corps of Engineers, 90 Church Street
New York, New York 10007 JUL 1 1976

TO: HQDA (DAEN-CWP-E), WASHINGTON, D.C. 20314

I concur in the recommendations of the New England Division Engineer that the results reported in this report be utilized by Federal, State, Regional and local entities as a basis for further planning and development of wastewater management under Sections 201, 208 and 303 of PL 92-500, and that the report and its supporting documents be transmitted to the Congress for its information.

James L. Kelly
JAMES L. KELLY
Major General, USA
Division Engineer